PROCEEDINGS OF THE

Twenty-first Annual Convention

OF THE

American Railway Bridge and Building Association

HELD AT

ST. LOUIS, MISSOURI
October 17-19, 1911

REPORTS IN THIS ISSUE

Fireproofing for Timber Trestles
Numbering Bridges
Buildings and Platforms for Small Towns
Pumping Engines
Concrete Tank Construction
Brick Veneer for Station Buildings
Roofs and Roof Coverings

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C. A. Lichty, Secretary
226 W. JACKSON BOULEVARD
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PROCEEDINGS OF THE

Twenty-first Annual Convention

OF THE

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF
BRIDGES AND BUILDINGS

HELD AT

ST. LOUIS, MISSOURI

OCTOBER 17-19, 1911

Official Badge

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ELGIN, ILLINOIS
1912

F. E. SCHALL
President, 1911-12

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Baltimore & Ohio Railroad.

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Duluth, Missabe & Northern Railway.

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J. P. Canty, ...Boston, Mass.
Boston & Maine Railroad.

J. S. Lemond, ...Charlotte, N. C.
Southern Ry.

H. Rettinghouse, ...Boone, Ia.
Chicago & North Western Railway.

*Deceased.

COMMITTEES FOR 1912

1. Fireproofing Timber Trestles.

    Lee Jutton, C. & N. W. Ry., Chicago, Ill.
    W. H. Moore, N. Y. N. H. & H. R. R., New Haven, Conn.

2. Derricks and Other Appliances for Handling Material in Supply Yards.

    J. N. Penwell, L. E. & W. R. R., Tipton, Ind.
    A. S. Markley, C. & E. I. R. R., Danville, Ill.
    A. Yappen, C. M. & St. P. Ry., Chicago, Ill.
    D. B. Taylor, B. & O. R. R., Wheeling, W. Va.
    E. A. Stanley, Mo. Pac. Ry., St. Louis, Mo.

3. Sash,—Size and Kind of Glass for Round Houses and Shops.

    A. A. Wolf, C. M. & St. P. Ry., Milwaukee, Wis.
    H. Bender, C. & N. W. Ry., Eagle Grove, Ia.
    P. E. Schneider, M. C. R. R., Jackson, Mich.
    F. L. Thompson, I. C. R. R., Chicago, Ill.

4. Concrete Tank Construction.

    F. E. Weise, C. M. & St. P. Ry., Chicago, Ill.
    W. H. Finley, C. & N. W. Ry., Chicago, Ill.
    W. M. Clark, B. & O. R. R., Pittsburgh, Pa.
    D. G. Musser, Pa. Lines W. of Pitts., Wellsville, Ohio.

5. Best and Most Economical Pumping Engines.

    C. E. Thomas, I. C. R. R., Chicago, Ill.
    J. Dupree, C. T. H. & S. E. Ry., Crete, Ill.
    G. H. Jennings, E. J. & E. Ry., Joliet, Ill.
    J. B. White, C. & N. W. Ry., Boone, Ia.

6. Roofs and Roof Coverings.

   T. J. Fullem, I. C. R. R., Chicago, Ill.
   G. W. Andrews, B. & O. R. R., Baltimore, Md.
   C. W. Richey, P. R. R., Pittsburgh, Pa.
   C. A. Marcy, C. & N. W. Ry., Chicago, Ill.
   J. H. Nuelle, N. Y. O. & W. R. R., Middletown, N. Y.
   H. H. Kinzie, N. Y. N. H. & H. R. R., Taunton, Mass.

7. Reinforced Concrete Culvert Pipe.

   L. D. Hadwen, C. M. & St. P. Ry., Chicago, Ill.
   H. H. Decker, C. & N. W. Ry., Winona, Minn.
   R. O. Elliott, L. & N. R. R., Nashville, Tenn.
   F. O. Draper, I. C. R. R., Chicago, Ill.
   F. E. King, C. M. & St. P. Ry., Milwaukee, Wis.
   George Loughnane, C. & N. W. Ry., Escanaba, Mich.

8. The Construction and Maintenance of Long Pipe Lines for Locomotive Water Supply, Intakes, Pump Pits, Reservoirs, etc.

   B. J. Mustain, E. P. & S. W. R. R., El Paso, Tex.
   E. S. Hume, W. A. Govt. Rys., Midland Jct., W. Australia.
   E. R. Floren, C. R. I. & P. Ry., Chicago, Ill.
   D. Burke, Southern Pacific Co., Tucson, Ariz.
   W. C. Dale, O. S. L. R. R., Salt Lake City.

9. The Development of Turntables to Meet Operating Conditions for the Modern Locomotive, showing most improved practice.

   C. E. Smith, Mo. Pac. Ry., St. Louis, Mo.
   J. S. Berry, S. L. S. W. Ry., St. Louis, Mo.
   F. G. Jonah, St. L. & S. F. R. R., St. Louis, Mo.
   A. S. Markley, C. & E. I. R. R., Danville, Ill.
   C. H. Fake, M. R. & B. T. R. R., Bonne Terre, Mo.

10. Track Scales—Construction and Maintenance.

   A. M. Van Auken, M. D. & G. R. R., Nashville, Ark.
   E. R. Wenner, L. V. R. R., Wilkes Barre, Pa.
   A. W. Merrick, C. & N. W. Ry., Boone, Ia.
   Wm. H. Vance, La. & Ark. Ry., Stamps, Ark.
   H. M. Jack, I. & G. N. R. R., Palestine, Tex.

11. Painting of Structural Iron or Steel, for both Bridges and Buildings.

   C. Ettinger, I. C. R. R., Chicago, Ill.
   R. H. Reid, L. S. & M. S. Ry., Cleveland, Ohio.
   E. E. Wilson, N. Y. C. & H. R. R. R., New York City.
   O. F. Barnes, Erie R. R., Susquehanna, Pa.
   O. F. Dalstrom, C. & N. W. Ry., Chicago, Ill.

12. Relative Merits of Brick and Concrete in Railway Buildings and Platforms.

George W. Hand, C. & N. W. Ry., Chicago, Ill.
H. A. Horning, M. C. R. R., Jackson, Mich.
G. H. Jennings, E. J. & E. Ry., Joliet, Ill.
Peter Hofecker, L. V. R. R., Auburn, N. Y.
W. F. Strouse, B. & O. R. R., Baltimore, Md.
E. M. Dolan, Mo. Pac. Ry., St. Louis, Mo.
D. G. Musser, Pa. Lines W. of Pitts., Wellsville, Ohio.
P. E. Schneider, M. C. R. R., Jackson, Mich.

NOMINATIONS.

R. H. Reid, L. S. & M. S. Ry., Cleveland, Ohio.
S. F. Patterson, B. & M. R. R., Concord, N. H.
J. H. Markley, T. P. & W. Ry., Peoria, Ill.
J. F. Parker, A. T. & S. F. Ry., San Bernardino, Cal.

RELIEF.

A. Montzheimer, E. J. & E. Ry., Joliet, Ill.

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Lee Jutton, C. & N. W. Ry., Chicago, Ill.

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G. W. Andrews, B. & O. R. R., Baltimore, Md.
W. F. Strouse, B. & O. R. R., Baltimore, Md.
S. C. Tanner, B. & O. R. R., Baltimore, Md.

OBITUARY.

J. N. Penwell, L. E. & W. R. R., Tipton, Ind.

Proceedings of the Twenty-first Annual Convention

OF THE

American Railway Bridge and Building Association

HELD IN THE PLANTERS HOTEL

St. Louis, Mo., October 17, 18 and 19, 1911

MORNING SESSION.

Tuesday October, 17, 1911.

The twenty-first annual convention of the association was called to order at 10 A. M., by President H. Rettinghouse.

Prayer was offered by Mr. J. N. Penwell.

The President:—We have with us today Mr. John Gundlach, president of the city council, who, in the absence of the mayor, will welcome us and tender us the keys of the city.

Mr. Gundlach:—Mr. President, ladies and gentlemen: It is the privilege of the chief executive of this city to confer the freedom of the city upon conventions that meet here. We have conventions of all kinds, some of which affect the public interest and public welfare more or less. I want to say that I am particularly delighted to note the promiscuousness, or rather the number of ladies present at this convention. I want to say, for the information of the ladies, that this city always feels safer with a convention that is attended by a large number of ladies. We know, however, that they are a deterrent on the exuberance of some of the convention delegates.

The mayor of the city is not able to be present, because this is the day of the annual police parade, and I want to say right here that I hope you will not connect the parade of the police with your convention; it is an annual custom and is simply a coincidence. I do not believe it will be necessary to call on the police during your presence here, on account of the great number of ladies that are present (Laughter).

Ladies and gentlemen, to be serious, in extending to you a wel-

come to the city, I do not mean to convey it as a mere matter of form, for I know, and I want you to feel, that every citizen in St. Louis is glad to welcome you and would have you carry away a good impression of the city. We do not claim to be Utopians. I do not think that you will find St. Louis to be the Utopia of civilization, but we have a great many things that will appeal to you and things which make. St. Louis a very attractive city. We are a large commercial city, perhaps more so than is evident to the average person who visits us; but if there is one thing that we are proud of, it is our homes, and those of you who are not familiar with this city, we invite to make an inspection of our homes. I think that if you carry away the correct impression of our homes you will get the best possible benefit from having visited the city.

Such a convention as this, of such a universal character, and of such wide-spread interest to the community, is really one of great importance. Every delegate to this convention should realize that your work is not merely mechanical, but brings into play a constructive intelligence that is of benefit to the whole community. The experience from year to year should teach us to do better.

Speculative railroad building has, fortunately or unfortunately, given place to investment railroading. It is a hopeful sign of the times that people are not going to build railroads just simply for the purpose of personal advancement or personal interest, but that the railroading of the future must be for the benefit of the community. The interest of the individual must always be merged with the interest of the community, for the greatest interest of the individual is the community interest, that being a bequest to posterity.

I trust that your deliberations while here will be marked with that degree of seriousness which you gentlemen can appreciate perhaps better than I, and that the convention will be an instructive one. I hope that the committee of arrangements will provide a series of entertainments which will make you forget your homes, temporarily, and that when you leave it will be with the hope of coming back at some future time and with a desire to tell your friends that St. Louis is a very good place to come to. I thank you (Applause).

The President:—I will call on one of our older members, Mr. Geo. W. Andrews, to respond to the address of Mr. Gundlach.

Mr. Andrews:—Mr. Gundlach, Mr. President, ladies and gentlemen: About ten minutes before we convened our president came

to me and said that he desired me to respond to the address of the mayor of St. Louis. While I regret very much that the mayor has been unable to attend, we certainly feel very grateful that he has sent such a worthy representative. I would say that we are not strangers to St. Louis. Twenty years ago a small number of men met in St. Louis and organized this association. We feel, therefore, that instead of being strangers in St. Louis, this organization is simply a child of St. Louis, and we have a full right to expect open arms from our mother. We have been received with open arms by all cities to which we have gone to hold our conventions, but we feel that we have a special right to demand open arms in St. Louis, and we are very glad indeed to come here.

If you will permit me to digress for a moment, I will give you a little story that I heard only a few days ago relative to "open arms." It appears that in an old colored church in one of the southern cities, presided over by Parson Johnson, the parson was one day caught embracing one of the ewe lambs of his congregation and the elders took exception. They called the old gentleman before the board, investigated the affair and asked him to state his reasons for embracing the handsomest ewe lamb in the congregation, and his response was: " Brethren, haven't you never seen the picture of the good man with the lamb in his arms? If the good man sets the example to us with the lamb in his arms, why shouldn't your parson have the lamb in his arms?" The deacons, after considering the matter, decided about as follows: " Whereas, it may be necessary for Parson Johnson to have a lamb in his arms, therefore, be it resolved, that when it does become necessary for Parson Johnson to have a lamb in his arms, that he make that lamb a ram lamb" (Applause). I think, Mr. President, that is one of the reasons a great many of us bring our wives to the convention (Laughter).

Now, Mr. Gundlach, I will not tire the association, nor you, but I will say, on behalf of the association, that we thank you, as the representative of St. Louis, for your hearty welcome, and I sincerely hope that we will make this the meeting place of each and every one of our ten-year anniversary conventions.

The President:—The next matter in order is the roll call which, however, is handled by a system of registration, and I ask every member who has not yet registered to do so as speedily as possible and to be sure about doing so, in order that no one will be missed. The registration cards are at the entrance to the convention hall. The registration showed the following members present:

Members Present at the 1911 Convention.

Aagaard, P., Supvr. B. & B., I. C. R. R. Chicago.
Aldrich, G., Supvr. B. & B., N. Y. N. H. & H. R. R., Boston.
Anderson, A., Gen. For. B. & B., L. S. & I. Ry., Marquette, Mich.
Andrews, G. W., Insp. Maint., B. & O. R. R., Baltimore, Md.
Beard, A. H. For. Carp., P. & R. Ry., Reading, Pa.
Bender, H., For. B. & B., C. & N. W. Ry., Eagle Grove, Ia.
Bibb, J. M., Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Bishop, M., Mast. Carp., C. R. I. & P. Ry., El Reno, Okla.
Bowers, Stanton, Mast. Carp., P. C. C. & St. L. Ry., Bradford, O.
Bowers, S. C., Mast. Carp. of Brs., P. C. C. & St. L. Ry., Steubenville, O.
Browne, J. B., Gen. For. B. & B., K. C. C. & S. Ry., Clinton, Mo.
Bruce, R. J., Supt. Bldgs., Mo. Pac. Ry., St. Louis, Mo.
Cardwell, W. M., Mast. Carp. Wash. Term. Co., Washington, D. C.
Carter, E. M., Supvr. B. & B., T. C. R. R., Nashville, Tenn.
Costolo, J. A., Insp. Trans. Boats, M. P. Ry., St. Louis, Mo.
Cunningham, A. O., Ch. Engr., Wabash R. R., St. Louis, Mo.
Dupree, J., Supt. W. S., C. T. H. & S. E. Ry., Crete, Ill.
Eggleston, W. O., Br. Inspr., Erie R. R., Huntington, Ind.
Elliott, R. O., Supvr. B. & B., L. & N. R. R., Nashville, Tenn.
Fake, C. H., Ch. Engr., M. R. & B. T. R. R., Bonne Terre, Mo.
Ferdina, A. H., For. B. & B., St. L. I. M. & S. Ry., St. Louis.
Frazier, W. C., Supvr. B. & B., S. P. L. A. & S. L. R. R., Los Angeles.
Fullem, T. J., Supt., Buildings, I. C. R. R., Chicago.
Griffith, F. M., Supt. B. & B., C. & O. Ry., Covington, Ky.
Guild, Edw., Supt. B. & B., P. M. R. R., Grand Ledge, Mich.
Gumphrey, M. E., Mast. Carp., C. R. I. & P. Ry., Eldon, Mo.
Hadwen, L. D., Eng. Mas. Con., C. M. & St. P. Ry., Chicago.
Hand, G. W., Asst. Engr., C. & N. W. Ry., Chicago.
Hausgen, W., Supvr. B. & B., Mo., Pac. Ry., Sedalia, Mo.
Hofecker, P., Supvr. B. & B., L. V. R. R., Auburn, N. Y.
Hall, Thos., Div. For., M. C. R. R., St. Thomas, Ont.
Hopke, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
Horning, H. A., Supt. B. & B., M. C. R. R., Jackson, Mich.
Jewell, J. O., Supt. B. & B., C. T. H. & S. E. Ry., Terre Haute, Ind.
Jonah, F. G., Ch. Engr. Const., Frisco Lines, St. Louis.
Jutton, Lee, Gen. Insp. Bridges, C. & N. W. Ry., Chicago.
Killam, A. E., Insp. B. & B., I. C. R., Moncton, N. B.
Large, H. M., Mast. Carp., G. R. & I. Ry., Ft. Wayne, Ind.
Larson, John, Ofs. Engr., 32 No. Clark St., Chicago.
Leake, T. S., Gen. Contractor, Chicago.
Lichty, C. A., Gen. Inspector, C. & N. W. Ry., Chicago.
Loftin, E. L., Supvr. B. & B., Q. & C. Ry., Vicksburg, Miss.
Mann, J. M., Gen. For. B. & B., F. W. & D. C. Ry., Ft. Worth, Tex.
Markley, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Markley, J. H., Mast. B. & B., T. P. & W. Ry., Peoria, Ill.
McKeel, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McLean, N., Mast. Carp., Erie R. R., Huntington, Ind.
McNab, A., Supvr. B. & B., P. M. R. R., Holland, Mich.
Meyers, W. F., For. B. & B., C. & N. W. Ry., Belle Plaine, Ia.
Moen, J. D., For. B. & B., C. & N. W. Ry., Boone, Ia.
Moore, W. H., Engr., Bgs., N. Y. N. H. & H. R. R., New Haven, Conn.
Mustain, B. J., Supt. W. S., E. P. & S. W. Ry., El Paso, Tex.
Noon, W. M., Supt. B. & B., D. S. S. & A. Ry., Marquette, Mich.
Nuelle, J. H., Engr. M. of W., N. Y. O. & W. Ry., Middletown, N. Y.
O'Neill, P. J., Mast. Carp., L. S. & M. S. Ry., Adrian, Mich.
Patterson, S. F., Gen. For. B. & B., B. & M. R. R., Concord, N. H.
Penwell, J. N., Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
Perkins, H. D., Danville, Ill.
Perry, W. W., Mast. Carp., P. & R. Ry., Williamsport, Pa.
Pickering, B. F., Supt. B. & B., B. & M. R. R., Salem, Mass.

Powell, W. T., Supt. B. & B., C. & S., Ry., Denver, Colo.
Rettinghouse, H., Div. Engr., C. & N. W. Ry., Boone, Ia.
Riney, M., For. B. & B., C. & N. W. Ry., Baraboo, Wis.
Robinson, J. S., Div. Engr., C. & N. W. Ry., Chicago.
Rohbock, W. L., Asst. to Ch. Engr., W. & L. E. R. R., Cleveland.
Sattley, R. C., Valuation Engr., C. R. I. & P. Ry., Chicago.
Schall, F. E., Bridge Engr., L. V. R. R., So. Bethlehem, Pa.
Scribner, C. J., Bldg. Inspr., C. B. & Q. R. R., Chicago.
Shedd, A. R., Asst. Gen. Brg. Insp., C. & N. W. Ry., Chicago.
Sheldon, J. B., Supvr., B. & B., N. Y. N. H. & H. R. R., Providence, R. I.
Stannard, Jas., 1602 Broadway, Kansas City, Mo.
Staten, J. M., Gen. Insp. Brdgs., C. & O. Ry., Richmond, Va.
Storck, E. G., Mast. Carp., P. & R. Ry., Philadelphia.
Strouse, W. F., Asst. Engr., B. & O., R. R., Baltimore.
Sweeney, W. M., For. B. & B., C. & N. W. Ry., Green Bay, Wis.
Tanner, S. C., Mast. Carp., B. & O. R. R., Baltimore.
Tanner, F. W., M. of W. Insp., Mo. Pac. Ry., St. Louis.
Taylor, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
Thomas, C. E., Gen. For., W. W., I. C. R. R., Chicago.
Thorn, J. O., Mast. Carp., C. B. & Q. R. R., Beardstown, Ill.
Weise, F. E., Chief Clerk, C. M. & St. P. Ry., Chicago.
Welker, G. W., Supvr. B. & B., Sou. Ry., Alexandria, Va.
Wenner, E. R., Supvr. B. & B., L. V. R. R., Ashley, Pa.
White, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
Wilkinson, J. M., Supvr. B. & B., C. N. R. R., VanWert, O.
Yappen, A., Dist. Carp., C. M. & St. P. Ry., Chicago.
Zook, D. C., Mast. Carp., Pa. Lines W., Ft. Wayne, Ind.

The following applicants for membership subsequently elected, were also present:

Case, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
Clopton, A. S., Supt. B. & B., M. K. & T. Ry., Parsons, Kans.
Ettinger, C., Gen. Ptr. For., I. C. R. R., Chicago.
Johnston, C. E., Ch. Engr., K. C. S. Ry., Kansas City, Mo.
Lawrence, P. P., Gen. Br. For., L. E. & W. R. R., Tipton, Ind.
Murray, Edw., Asst. Engr. B. & B., C. M. & P. S. Ry., Miles City, Mont.
Musgrave, C. T., For. B. & B., O. S. L. R. R., Idaho Falls, Idaho.
Schneider, P. E., Archt., M. C. R. R., Jackson, Mich.
Smith, C. E., Bridge Engr., Mo. Pac. Ry., St. Louis.
Swartz, H. C., Mast. B. & B., G. T. Ry., St. Thomas, Ont.
Taylor, J. J., Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
Teaford, J. B., Supvr. B. & B., Sou. Ry., Princeton, Ind.
Van Auken, A. M., Ch. Engr., M. D. & G. R. R., Nashville, Ark.
Wallenfelsz, John, Mast. Carp., Pa. Lines W., Cambridge, O.
Warcup, C. F., For. W. S., G. T. Ry., St. Thomas, Ont.

Total number registered, 102.

The President:—The next matter in order is the reading of the minutes of the last meeting, but inasmuch as they have been printed we will dispense with the reading as has been our custom. It will, however, be necessary that a motion be made to that effect.

On motion the reading of the minutes was dispensed with.

Next in order will be the president's address.

PRESIDENT'S ADDRESS.

We have again assembled at the birthplace of this association. When, 20 years ago, a little band of faithful members of the bridge and building craft gathered in this city to organize themselves into what they styled the American International Association of Railway Superintendents of Bridges and Buildings it was little thought at that time what proportions the newly born child would assume, how it would grow, and what important position it was destined to occupy in the railroad world. Today we can proudly look back upon our achievements, and pay tribute fitting and well earned to the founders of this association. Well may we be proud not only of the results of our investigations, our committee reports and discussions that have gone forth, in the shape of our annual publication to become a text book in bridge and building work; not only may we be proud of the personal achievements and successes of individual members; but we may, also, and not leastly, be proud of the good and harmonious feeling, the good fellowship which has ever existed and today does exist and will continue to exist in our beloved organization.

When the founders of this society met for the first time in annual convention in this city there was no contention, or dissension whatever, but we read in the proceedings of the first annual convention (and the book of proceedings is very small, only 8 pages against about 300 pages of today's proceedings) how harmoniously the business was conducted. This spirit has prevailed throughout the twenty years of existence, and the men elected by this association to conduct its affairs have been of the right stamp, and they have preserved the spirit of old. There has been always a spirit of tolerance and broad gauge good fellowship. We have not permitted political or religious discussions in or out of the convention hall. We have ever been adhering to the stout belief that the Almighty cares not whether one human being has accidentally been thrown into the bosom of this church, and another into the bosom of another church, and that God looks with a kindly eye upon him who loves his neighbor as himself; who carries out his mandates in his own fashion; who is true to his fellow beings and to himself; and who spreads the gospel of brotherly love.

Some of the old guard are still with us, and some of them are present at this convention. It is needless to say that we all extend to them the glad hand of welcome to this our home-coming day. It is a home-coming day indeed, and, personally, it is a home coming to me, as I joined the association at the convention in this city in 1900.

I want to tell you of a little incident that happened at that time, and which goes to show that even then some of the older members would be mistaken in their judgment. My wife, who, as usual, had me in tow on the morning of the first day of the convention, led me to a table in the breakfast room of the Southern hotel, where another elderly couple were already seated. We concluded from their conversation, that they belonged to the great family of convention people, but as my wife is rather timid, and I am more so, we did not at once seek to make ourselves acquainted. However, we became quite intimately acquainted with the same couple later on, and some years after were told by them that they thought we were a newly-married couple and on our wedding trip. Now, when it is considered that I was so close to 40 years as to leave but little margin (I won't tell you how old my wife was), it is doubly strange that Bro. W. O. Eggleston and his estimable wife (who were the couple in question) should display such bad judgment.

I have told you that I was timid at that time. I listened attentively to the discussions, but could not muster up enough courage to get up and take part in the proceedings. I have often noticed since that time that new members act likewise, and at their first convention they will be as silent as the tomb, and much valuable information will remain dormant. I believe it to be the duty of the presiding officer to bring our new members into the dis-

cussions, and I want, therefore, to serve fair notice on all new members that they will be called upon.

In the past most of our presidents have, in their annual addresses, given a resume of the association's history. I find that it will be a useless trespass upon your time to do so, as our able secretary has relieved me of that duty through his recent publication in the association "Bulletin," giving both the early and the late history of the association.

The reports of the secretary and treasurer will be received in regular form later, and will give you in comprehensive form all the business information desired. Suffice it, therefore, to say that our membership, from a charter list of 60, in 1891, and a membership of 143, in 1900, has steadily grown to a present membership of 500. We are, therefore, prosperous.

Death has invaded our ranks and has removed from us W. B. Wood, T. A. Causey, H. M. Henson, C. F. Spencer, also three pioneers in the bridge and building service, H. P. Morrill, Henry Crane and W. D. Walden. It is a strange and sad coincidence, that the three last named were all life members of this association and retired employés of the Chicago & Northwestern Ry. The committee on memoirs will fittingly pay tribute to the memory of these departed members. To me, personally, it has been a greater loss, as I was intimately acquainted with all three of them, and in a business way connected with one of them, the late W. D. Walden, and a grand old man and a jewel in his profession.

One thing more: I can not thank too much our secretary for his untiring efforts in behalf of this association in general, and his equally untiring efforts in my personal behalf. As many of you know, I was suddenly stricken with what nearly proved to be a fatal illness, which prevented me from attending the executive committee meeting in Chicago, in March, and which made me unfit for business for several months later, and which was only relieved through a serious operation. Brother Lichty went about and did my association work in addition to his own, and I can not thank him too much. In thanking you, therefore, for the honor which you bestowed upon me a year ago, it is but just to you to say that I have been but poorly able to fulfill my duties.

From the information on hand it appears that we have some valuable committee reports, and there is promise of valuable and interesting discussions. We want all of you to display full interest, as such will be necessary in order to make the discussions valuable, and enable us to present to the railroad world, as recommended practice, methods which have been tested out; and thereby uphold and strengthen the reputation of the American Railway Bridge and Building Association.

The President:—The next in order is the report of the committee on membership.

REPORT OF MEMBERSHIP COMMITTEE.

Salt Lake City, Oct. 15, 1911.

The membership committee sent out application blanks and circulars as has been the custom for several years. The first page of the circular gave a list of the officers and the members of the executive committee; pages two and three set forth the aims and purposes of the association, and contained the invitation for making application for membership; page four contained a list of the subjects for report and discussion to come before the St. Louis convention.

Each member of the committee worked a certain territory and the secretary rendered valuable assistance in connection with the work of the committee in writing personal letters. The personal work of individual members added greatly in making this list of 93 applicants the largest in the history of the organization, the next largest class having been presented in 1904, when 89 were added to the membership.

Our membership has grown wonderfully in the western territory during the past two years, and we are especially indebted to Mr. Rear for his personal work on the Pacific slope. He has presented the names of about 40 applicants during the past fourteen months.

The following list of applicants is presented for your consideration at this meeting:—

NEW MEMBERS.

E. E. Allard, For. B. & B., Mo. Pac. Ry., St. Louis.
F. J. Arnold, Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
C. J. Astrue, Asst. Engr., Sou. Pac. Co., Oakland Pier, Cal.
G. E. Boyd, Supt. B. & B., D. L. & W. R. R., Scranton, Pa.
Hugh Bulger, For. B. & B., Sou. Pac. Co., Oakland Pier, Cal.
W. H. Burgess, Supvr. B. & B., Sou. Pac. Co., Stockton, Cal.
E. Cahill, Genl. For. B. & B., D. L. & W. R. R., Binghamton, N. Y.
J. T. Caldwell, For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
F. M. Case, For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
A. S. Clopton, Supt. B. & B., M. K. & T. Ry., Parsons, Kans.
J. F. Cullen, For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Wm. C. Dale, For. W. S., O. S. L. R. R., Salt Lake City.
O. F. Dalstrom, Ch. Dftsm. Br. Dept., C. & N. W. Ry., Chicago.
Geo. Dickson, For. Brdgs., Sou. Pac. Co., Oakland, Cal.
E. M. Dolan, Bldg. Inspr., Mo. Pac. Ry. Sys., St. Louis.
H. S. Douglass, Supvr. B. & B., Sou. Ry., Charleston, S. C.
H. A. Elwell, Supvr. B. & B., C. G. W. Ry., Clarion, Ia.
C. Ettinger, Gen. Ptr. For., I. C. R. R., Chicago.
A. H. Ferdina, For. B. & B., St. L. I. M. & S. Ry., St. Louis.
J. F. Fisher, Bridge Inspr., Sou. Pac. Co., Sacramento, Cal.
Morris Fisher, Supvr. B. & B., Sou. Pac. Co., Ogden, Utah.
Oscar Forsgren, For. B. & B., O. S. L. R. R., Brigham, Utah.
Phil. Fritz, For. B. & B., Sou. Pac. Co., Los Angeles.
J. A. Givens, Asst. Div. Engr., Sou. Pac. Co., Sacramento, Cal.
C. Gnadt, Br. For., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
Lon Graves, For. B. & B., St. L. I. M. & S. Ry., Monroe, La.
Peter Guisto, For. B. & B., Sou. Pac. Co., San Francisco.
N. L. Hall, Supvr. B. & B., Sou. Ry., Greensboro, N. C.
Wm. C. Harmon, Br. Inspr., Sou. Pac. Co., Bakersfield, Cal.
W. B. Harris, Div. Engr., M. & O. R. R., Murphysboro, Ill.
H. R. Hill, Asst. Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
J. W. Holcomb, Supvr. B. & B., L. V. R. R., Buffalo, N. Y.
Jno. Hubley, Steel Br. For., Sou. Pac. Co., Colfax, Cal.
J. M. Hurt, For. B. & B., T. C. R. R., Nashville, Tenn.
C. A. Jensen, For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
C. E. Johnston, Ch. Engr. K. C. Sou. Ry., Kansas City, Mo.
A. E. Kemp, Supvr. B. & B., L. V. R. R., Hazelton, Pa.
G. W. Kinney, Inspr. B. & B., D. & R. G. R. R., Salt Lake City.
M. R. Krutsinger, Supvr. B. & B., W. Pac. Ry., Sacramento, Cal.
W. J. Lacy, For. B. & B., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
A. W. Lasher, Asst. Engr., Sou. Pac. Co., Suisun, Cal.
P. P. Lawrence, Genl. For. Brdgs., L. E. & W. R. R., Tipton, Ind.
T. J. Linehan, For. Brdgs., Sou. Pac. Co., Ventura, Cal.
Harry Lodge, For. B. & B., Sou. Pac. Co., San Francisco.
J. B. Malloy, For. B. & B., Sou. Pac. Co., San Francisco.
J. D. Mathews, Div. Engr., Sou. Pac. Co., Tucson, Ariz.
F. D. Mattos, Supt. Wood Pres. Wks., S. P. Co., W. Oakland, Cal.
C. W. McCandless, For. B. & B., Sou. Pac. Co., Ventura, Cal.
R. S. McCormick, Ch. Engr., A. C. & H. B. Ry., Sault Ste. Marie, Ont.
Danl. McGee, For. B. & B., Sou. Pac. Co., Sacramento, Cal.
Angus M. McLeod, For. B. & B., Sou. Pac. Co., Oakland, Cal.
A. McQueen, Gen. For. Brs., D. L. & W. R. R., Binghamton, N. Y.

D. A. McRae, Carp. For., C. P. R., Cranbrook, B. C.
E. S. Meloy, Asst. Engr., C. M. & St. P. Ry., Chicago.
E. C. Morrison, Div. Engr., Sou. Pac. Co., San Francisco.
Edwd. Murray, Asst. Engr., B. &. B., C. M. & P. S. Ry., Miles City, Mont.
C. T. Musgrave, For. B. & B., O S. L R. R., Idaho Falls, Idaho.
W. V. Parker, For. B. & B., Rock Island Lines, Amarillo, Tex.
P. E. Parsons, For. B. & B., O. S. L. R. R., Salt Lake City.
S. J. Powell, Div. For. B. & B., O. S. L. R. R., Ogden, Utah.
J. E. Ranney, Genl. For. B. & B., D. L. & W. R. R., Buffalo, N. Y.
A. G. Rask, Supvr. B. & B., C. St. P. M. & O. Ry., Spooner, Wis.
C. E. Redmond, Supvr. B. &. B., St. L. I. M. & S. Ry., Van Buren, Ark.
J. S. Replogle, For. B. & B., Sou. Pac. Co., Oakland, Cal.
R. W. Richardson, Asst. Engr., C. & N. W. Ry., Sioux City, Ia.
A. L. Robinson, Br. Inspr. Sou. Pac. Co., Stockton, Cal.
R. B. Robinson, Asst. Engr., O. S. L. R. R., Rupert, Idaho.
Aug. Ruge, Supvr. B. & B., C. St. P. M. & O. Ry., Mankato, Minn.
D. W. Scannell, For. B. & B., S. P. L. A. & S. L. R. R., Salt Lake City.
P. E. Schneider, Architect, M. C. R. R., Jackson, Mich.
W. W. Sheldon, For. B. & B., Sou. Pac. Co., Oakland, Cal.
Jas. Skeoch, Gen. For. B. & B., D. L. & W. R. R., Dunmore, Pa.
C. E. Smith, Br. Engr., Mo. Pac. Ry. Sys., St. Louis.
A. C. Snyder, For. B. & B., D. & R. G. R. R., Glenwood Springs, Colo.
H. Stamler, Supvr. B. & B., L. & N. R. R., Paris, Ky.
E. A. Stanley, Supvr. B. & B., Mo. Pac. Ry., St. Louis.
C. A. Stelle, Div. Engr., W. & L. E. R. R., Canton, O.
W. A. Swallow, Ch. Engr., Ga. & Fla. Ry., Augusta, Ga.
H. C. Swartz, Master B. & B., G. T. R., St. Thomas, Ont.
J. J. Taylor, Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
J. B. Teaford, Supvr. B. & B., Sou. Ry., Princeton, Ind.
E. E. Templin, For. Carp., P. & R. Ry., Pottsville, Pa.
J. E. Travis, Br. For., I. C. R. R., Carbondale, Ill.
J. H. Travis, Insp. Iron Br. Erec., C. & N. W. Ry., Chicago.
A. M. Van Auken, Ch. Engr., M. D. & G. R. R., Nashville, Ark.
E. J. Vincent, For. B. & B., Sou. Pac. Co., Los Angeles.
J. Wallenfelsz, Mast. Carp., Pa. Lines W., Cambridge, O.
C. H. Walther, Supvr. B. & B., Mo. Pac. Ry., Poplar Bluff, Mo.
C. F. Warcup, For. W. S., G. T. R., St. Thomas, Ont.
Norton Ware, Br. Engr., W. Pac. Ry., San Francisco.
A. Weldon, For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
B. F. Whiting, Supvr. B. & B., M. & O. R. R., Murphysboro, Ill.
J. P. Wood, For. B. & B., P. M. R. R., Edmore, Mich.

Total number of new members, 93.

Respectfully submitted,

A. H. King, *Chairman.*

The Secretary was instructed by a vote of the association to cast one ballot for the election of the applicants, making them members, whereupon they were declared as being entitled to all the rights and privileges of the association.

A recess was taken for distributing the badges and for the payment of annual dues.

The President:—Before proceeding I want to say that in order to help out matters we will ask each member on rising to mention his name, in order to aid the stenographer in his work. I will appoint Mr. Lee Jutton to act as assistant secretary during this con-

vention. I wish to announce that when we adjourn at 12 o'clock, we will go to the court house to have a group picture taken, to include ladies and visitors.

We will next have the report of the executive committee.

REPORT OF EXECUTIVE COMMITTEE.

At the close of the Denver meeting it was decided to grant a loan of $100 to Mr. H. M. Henson, to enable him to keep up his life insurance policy.

The secretary was authorized to have printed 1,200 copies of the proceedings; six hundred copies to be bound in cloth and a like number to be bound in paper covers.

The expenses of the committee on arrangements for the Denver convention were paid by the secretary from the funds of the association.

It was decided to have a meeting of the executive committee at Chicago in the month of March at a time to be announced by the president.

About thirty members met at the Congress Hotel, Chicago, March 22, 1911. Matters pertaining to the welfare of the association were discussed, but no regular business was transacted.

A business session was held at the Planters Hotel Monday evening, Oct. 18, 1911. The secretary was authorized to purchase such articles of furniture as were necessary for keeping the files and records of the association. An outline of the features of entertainment was gone over with the chairman of the committee on arrangements.

The secretary reported that the loan of $100 which had been made to Mr. Henson one year ago had been returned, after having been used to pay his life insurance premium, which was of considerable importance, for Mr. Henson died about two months later and the family were able to receive the amount due from the insurance, which might otherwise have been forfeited.

No further business appearing, the meeting was adjourned.

The President:—We will now have the reports of the secretary and of the treasurer.

REPORT OF THE SECRETARY.

It may well be said that the association is in a growing and prosperous condition. Our membership has steadily increased until we are beyond the five hundred mark. Most of the new members which have joined the association in the past two years are from the western half of the United States, which is largely due to the personal efforts of Mr. Geo. W. Rear and Mr. A. H. King.

Twelve hundred copies of our 1910 proceedings were issued, one-half in paper covers, the other half in cloth binding. There has been a growing demand for our publication from libraries, technical societies and institutions of learning, and all such institutions making application have been furnished.

Four numbers of the Bulletin were issued during the year. The secretary would urge upon all members the importance of sending in items of interest for publication.

Death has removed from our midst eight of our most worthy members. Memoirs of these deceased brothers will be published in the proceedings.

FINANCIAL.

RECEIPTS.

Balance on hand last report,	$ 435.77	
Fees and dues,	961.00	
Advertisements,	1,451.80	
Sale of books,	19.50	
Badges,	8.00	$2,876.07

EXPENDITURES.

Stationery and office supplies,	$ 9.65	
Postage,	115.14	
Printing,	840.69	
Drafting,	35.00	
Editing,	65.00	
Badges,	79.80	
Treasurer's bond,	7.50	
Stenographer,	125.00	
Committee expenses,	18.70	
Salaries,	600.00	
Expenses, Secretary Emeritus,	52.05	
Annual meeting expenses,	213.90	
Telegrams, express, etc.,	14.75	
Miscellaneous items,	15.50	$2,192.68
Balance on hand,		$ 683.39

C. A. Lichty,
Secretary.

REPORT OF THE TREASURER.

Cash on hand, last report,	$1,272.55
Interest to Jan. 1, 1911,	12.85
Cash on hand Jan. 1, 1911,	$1,285.40
Interest to July 1, 1911,	25.70
Balance on hand Oct. 19, 1911,	$1,311.10

J. P. Canty,
Treasurer.

The President:—I have just a few things that I want to say in connection with the forthcoming business. There has been a good deal of valuable time lost heretofore in our association meetings because the members wander away from the subject, and although I may make some enemies during these business meetings I want it understood that I shall not allow any digression from the subject whatever. I ask the members to aid me in enforcing this rule. It has often happened that while discussing, for instance, gasoline engines, some member would get up and before he got through he might be talking about a load of hay. There is too much time lost in this way and I believe, if the members will assist, that we

will have our business conducted more intelligently. I do not want to be understood as criticising any of my predecessors, but nevertheless you will agree with me that this rule should be enforced.

It has always been my experience that during the first day of the convention, the largest and best interest is manifested, and we want therefore, to do as much work today as possible. The executive committee discussed this matter in a short meeting last night, and among other things decided to hold a session tonight which, however, may be short, and the subject matter for that session will consist of the report of the committee on "Roofs and Roof Coverings." There will be some outside parties who will address us on the subject and that will make the meeting doubly interesting.

The President:—Next in order will be the appointment of committees. I will appoint, as a committee to audit the books of the secretary and those of the treasurer, W. O. Eggleston, J. N. Penwell, and G. Aldrich.

The committee on resolutions will be J. H. Markley, J. M. Staten and James Stannard.

The committee on selection of subjects for report and discussion for our next convention will consist of G. W. Andrews, A. S. Markley and F. E. Weise.

The Secretary:—I wish to announce that I have a number of subjects on hand which the committee may use, if they wish, in making up their list.

The President:—We will now receive the report of the committee on relief.

REPORT OF RELIEF COMMITTEE.

Joliet, Ill., Oct. 17, 1911.

To the Members of the American Railway Bridge and Building Association:

The committee on relief takes pleasure in reporting that during the past year no requests have been made for help in securing positions. A temporary loan of $100 was made to a member who was sick and out of work. This amount has since been returned to the association.

Yours truly,

ARTHUR MONTZHEIMER,
Committee.

The President:—If any one knows of a member in need of relief he will please report the matter.

The secretary will read a letter of interest to the association.

(The secretary read a letter received by him from Mr. Travis, the founder of the association.)

Everett, Wash., Oct. 5, 1911.

Mr. C. A. Lichty, Secretary Am. Ry. B. & B. Assn., Chicago,

Dear Sir:—I had hoped until the present time that I would be able to be in St. Louis to meet with you at the twenty-first anniversary of the association, but my hopes have been in vain, and I must forego the pleasure. I can assure you, however, that my heart will be with you in that meeting. It was in that beautiful city, twenty years ago, that we met to organize this grand organization. What a wonderful perspective it had in our minds! It has not disappointed us, yet the child has grown to larger proportions than I had anticipated. May we have reverence for those good, faithful souls who have passed to the beyond, and we say thanks to those of the old guard who are still with us, some of whom, no doubt, will be with you in the coming meeting. In this connection, if I remember correctly, a number of the early members no longer appear on the roll. Some of them, perhaps, were dropped for non-payment of dues. If so, it may not have been so much their fault as their misfortune. If such be living would it not be a charitable act to restore their names to the roll? It can not injure the association to do this, and it would be appreciated very much by them.

I hope, and I know, that you will have a good meeting. I wish I could be there to renew old acquaintances, and give a glad hand-shake to the new members.

My kindest regards to them all.

Most sincerely yours,

O. J. Travis.

The Secretary:—I would suggest, fellow members, that we send a telegram of greetings to Mr. Travis.

The President:—The suggestion is a good one, and I do not think it necessary to put this in the form of a motion. I am satisfied that every member will be heartily in favor of the proposition. I will appoint Mr. G. W. Andrews to formulate a telegram, and the secretary will please forward it.

The telegram which was sent to Mr. Travis read as follows:

"Greetings to the founder of this association, with regrets for his absence." (Signed by the President.)

We will next receive the report of the auditing committee.

St. Louis, Oct. 17, 1911.

To the Officers and Members of the American Railway Bridge and Building Association:

The auditing committee has carefully examined the books and accounts of the secretary and of the treasurer and find that the reports, as presented, are correct.

Respectfully submitted,

W. O. Eggleston,
J. M. Penwell,
G. Aldrich,
Committee.

The report was received and placed on file and the committee discharged.

The President:—Mr. Jutton will now read the report of the committee on Fireproofing of Timber Trestles. (See report, Subject No. 1.)

Gentlemen, you have heard the report. The subject is now open for discussion. (See discussion.)

Mr. J. H. Markley:—I move that we adjourn until two o'clock.

The President:—Before we adjourn I wish to remind you all that a group picture is to be taken at 12:30 at the east steps of the court house, just across the street from the hotel.

The meeting adjourned.

AFTERNOON SESSION.

Tuesday, October 17, 1911.

The meeting was called to order at 2 P. M. by the president.

The President:—We will continue the discussion of Fireproofing Timber Trestles.

Mr. J. H. Markley:—I wish to know why we have no advance copies of these reports at hand?

The Secretary:—I can furnish the information called for by Mr. Markley. The reports have been later than usual this year. Up to two weeks before convention time we had not sufficient copy on hand to make half a dozen pages of printed matter.

When a few of them came in I took them to the printers, but they can not always get them out on a few days' notice. We expected three of these reports this morning, but they have not yet arrived. We will have but three reports in printed form. The others we shall have to read from the original manuscript. Some of these have not been put in first class shape, but that will be accomplished before we send the copy to the printers. This has prevented us from sending out advance copies this year, as we ought to do and as we have done heretofore. It is quite a job to send the advance copies out by mail and there is no use of mailing them unless it can be done several weeks before the convention. We ought to have them out at least a month in advance. I am making this complaint now, so that future committees will perhaps get to work a little earlier in the season and get the reports out in time to have them published and sent out several weeks prior to the convention. We will then have opportunity to come to the meetings fully prepared for the discussion of the various subjects.

The President:—Has Mr. Penwell his report ready, Subject No. 2, "Derricks and Other Appliances for Handling Material in Supply Yards"?

Mr. Penwell:—This report is not complete and I would like

to offer an excuse. It has been suggested to me by other members of the committee that the subject be continued another year. We sent out 150 letters to the various railroads, all over the United States and Canada, and a few to foreign countries, from which we have received 31 replies. These replies represent 25 railroad companies, sixteen of which have no derricks or appliances whatever for handling their material in the bridge and building yards. The Illinois Central R. R. has presented a very fine plan of a yard and some derricks of their own make, and the New York, New Haven & Hartford R. R. has also some photographs of derricks and a plan of their material yard. The Boston & Maine R. R. has given some information on the subject. Two members from the Baltimore & Ohio R. R.—Mr. Andrews and Mr. Taylor—have written very interesting letters. One road has reported using an electric crane in its yard, and so on.

Ninety per cent of the letters received refer to the use of elaborate derricks for handling iron bridges in the field, which are sometimes used in the yard. We have heard from only about six railroads that have given us the real information desired in regard to the derrick that is used in the yard exclusively.

The committee has decided that if the report is to include appliances which are taken to the field that they can not properly be classed as yard derricks for they may not be on hand when needed most, as in the case of loading material for a washout or a fire. For that reason we would like to have the subject continued, so that we can get additional information and turn the report in next year. This is an important subject. We all know that considerable money is wasted in handling timber in an awkward manner, or on account of the lack of equipment with which to handle it.

The President:—If there is no objection I will take it for granted that it is the wish of the association that the subject be continued next year and that the information submitted by Mr. Penwell be received as a report of progress. I will suggest that the committee on subjects recommend a continuation of this subject for next year, and I would also advise the incoming president to continue the same committee.

We will pass to Subject No. 3, "Best Method of Numbering Bridges."

The report of the committee will be read by the assistant secretary. (See report.)

The President:—Gentlemen, the report is open for discussion. (See discussion.)

After the subject had been discussed for some time it was decided to pass it without making any specific recommendations.

The President:—We will now take up Subject No. 4, "Arrangement of Depot and Platforms for Small Towns, As to Convenience and Appearance." This report was continued from last year. Mr. Fake will please read the report. (See report and discussion.)

We will next take up the report on Subject No. 9, " Brick Veneer for Station Buildings." Mr. Gumphrey is chairman of that committee.

The Secretary:—Mr. Gumphrey has just this moment left the room. He received word that a Rock Island bridge on his territory near here, was wrecked by a derailed train and he went there at once upon receiving the information. This report has not been put in first-class shape, but it will be put in proper condition before going to the printer. In the absence of Mr. Gumphrey I will read the report, and we can then go on with the discussion.

After the discussion it was decided to discontinue the subject.

The secretary read a letter from Mr. McGonagle as follows:

Duluth, Minn., Oct. 15, 1911.

Mr. C. A. Lichty, Secy., Planters Hotel, St. Louis.

Dear Sir:—I sincerely regret that I am compelled to announce my inability to be present at the twenty-first annual meeting of our Bridge and Building Association to be held at St. Louis this month. I am just leaving for New York on important railroad business, and it appears at this time impossible for me to return in time for the meeting.

Will you kindly express to the members the disappointment that I feel in being deprived of the privilege to meet with them this year? I sincerely trust, however, that some time in the near future I may find that business conditions will permit me to meet with them again.

Wishing you a successful and profitable meeting, I am,

Very sincerely yours,

W. A. McGonagle.

The President:—Mr. McGonagle was one of the charter members of this association and we certainly regret his inability to be with us at this time.

Mr. J. H. Markley:—It is now about 5:30, and I move that we adjourn until tomorrow morning.

The President:—Pardon me but before putting your motion I wish to explain that it has been made a special order of business to take up this evening at eight o'clock, the report of the committee on roofs and roof coverings. Mr. Coburn, of the Vandalia Line, who is chairman of the committee on roof coverings for the American Railway Engineering Association, has given that subject very

close attention and he will be here on my invitation to give us a talk on that subject and take part in the discussion tonight. If you will kindly amend your motion to state that we adjourn until eight o'clock tonight, I will put the motion.

Mr. Markley:—I accept the amendment.

The Secretary:—I wish, before adjournment, to state that we are to have an informal reception after the business session tonight in order to give the members and their friends an opportunity to get better acquainted.

Meeting adjourned until 8 P. M.

EVENING SESSION.

Tuesday evening, October 17, 1911.

The meeting was called to order at 8 o'clock by President Rettinghouse. The assistant secretary read the report on Subject No. 10, "Roofs and Roof Coverings."

After this a lively discussion occupied several hours. (See discussion.)

Several of the supply men were permitted to express their views in regard to roofing materials, with the understanding that no firm name or trade marks be mentioned. The result was that the association received some good general information from several non-members, all of which is shown under the head of discussion of this subject.

The secretary stated that it would be necessary that all members who wished to see the test made on the Missouri Pacific Ry. bridge the following day should be ready promptly at 11:30. (This had reference to a bridge which had been treated with Clapp's fire-resisting paint.)

The meeting adjourned until 9:30 A. M. Wednesday, after which a social hour was spent in an informal reception in the parlors of the hotel which was enjoyed by the members, their families and visiting friends.

MORNING SESSION.

Wednesday, October 18, 1911.

Business was resumed at 9:30 A. M. with the president in the chair.

The President:—We are experiencing a great deal of anxiety

in regard to the reports which the secretary had printed, and which were to be forwarded here by express. This goes to show that we must be more prompt hereafter with our committee reports. If they are not printed and in the hands of the members before coming to the convention it does not give them an opportunity to study them. The mere reading of a report here does not bring out a full discussion, because it is difficult to grasp it so quickly, and the various points do not impress themselves upon the minds of the members as forcibly as is likely to be the case when each one can give it deliberate attention.

I hope that the incoming president will meet with better success, and I will ask every one present to appoint himself a committee of one to get all of the rest of the members lined up on this matter, so that we will have a better opportunity for the discussions next year.

The secretary advises that there is no report on Subject No. 5, Sash, Size and Kind of Glass for Roundhouses and Shops. It is very unfortunate that we have no report on this subject, because it is one in which we are all interested. I am personally interested in it and I know that a number of others are. It will be necessary, of course, to continue this subject for next year, and if the present committee will not produce results another one should be appointed.

We will take up the report which has been presented on Subject No. 8, Concrete Tank Construction.

Mr. Weise not being present, Mr. Jutton, the assistant secretary, began reading the report, which was concluded by Mr. Weise upon his return to the hall.

The President:—This report is quite complete and the committee is entitled to our thanks for the very able manner in which the subject is presented. The chairman of the committee has given a great deal of his time to its preparation and is entitled to more than ordinary credit.

Before entering upon the discussion on this subject I wish to call attention to paragraph five of our by-laws, which states that the report of the nominating committee is to be read at the first session of the second day. The assistant secretary will read the report of the committee. At the same time I wish to call attention to Section 1, of Article VII, of our constitution in which it states that "nothing in this section shall be construed to prevent any member from making nominations."

The report of the committee was read, and was as follows:

REPORT OF THE NOMINATING COMMITTEE.

To the Members of the American Railway Bridge and Building Association:

The committee on nominations begs leave to submit the following names for officers of this association for the ensuing year:

President—F. E. Schall, L. V. R. R.
First Vice-President, A. E. Killam, I. C. R. of Canada.
Second Vice-President, J. N. Penwell, L. E. & W. R. R.
Third Vice-President, L. D. Hadwen, C. M. & St. P. Ry.
Fourth Vice-President, T. J. Fullem, I. C. R. R.
For members of the Executive Committee: G. Aldrich, P. Swenson, G. W. Rear, W. F. Steffens, E. B. Ashby, W. O. Eggleston.

R. H. Reid,
J. F. Parker,
S. F. Patterson,
A. Montzheimer,
J. H. Markley,
Committee.

The President:—The report will lie over until the third day of the convention, when the election of officers will take place.

There is another matter that will have to be given preference to the discussion of the subject which is before us, which will require a short executive session of the entire association, and I therefore request that all those who are not members, including the press, retire for a short time. I will ask Mr. Penwell to guard the doors so as to admit none but members.

The executive session consisted of a discussion pertaining to matters relative to certain features of entertainment in connection with members and non-members of the supply men's association.

When the executive session was concluded the discussion of Subject No. 5 was taken up. (See discussion.)

It was decided to continue the subject another year.

AFTERNOON SESSION.

Wednesday, October 18, 1911.

Upon returning from the Missouri Pacific Ry. bridge, where was given the test of the fire-resisting paint, the members convened for continuing the discussion on the various subjects.

Mr. Thomas was called upon for the reading of his report on Subject No. 6, Best and Most Economical Pumping Engines. The report was read by the assistant secretary, whereupon Mr. Thomas stated for the committee that their report was rather one of progress, for the reason that it was not complete.

Mr. Thomas stated that some roads were engaged in making changes whereby gasoline engines were being replaced by those which use a distillate, or simply putting on an attachment to the gasoline engine, so that it can be run on oil costing 2½ to 3 cents,

instead of gasoline costing 10 to 12 cents, per gallon. (See discussion.)

It was finally voted to continue the committee.

The discussion on the subject of Fireproofing Timber Trestles was resumed. Mr. Jutton suggested that the committee be continued and be empowered to conduct a number of tests with fire-resisting paints, and like materials. After considerable discussion it was so decided.

The next report to be taken up was on Subject No. 11, Embankment Protection, which was followed by a lively discussion. (See discussion.)

The report was accepted and the committee discharged.

There was no report on Subject No. 7, Records of Bridges, Buildings and Other Structures.

The President:—We will now receive the report of the obituary committee.

REPORT OF THE OBITUARY COMMITTEE.

To the Members of the American Railway Bridge and Building Association:

Whereas, our Heavenly Father in his divine wisdom has called from our midst eight of our beloved members, several of whom were our oldest and most respected brothers, thus reminding us of the uncertainty of life and the certainty of the final summons, therefore be it

Resolved, That we deeply and sincerely mourn the loss of these faithful members: W. D. Walden, Henry Crane, H. P. Morrill, H. M. Henson, T. A. Causey, E. C. Spaulding, W. B. Wood and C. F. Spencer.

Resolved, That our secretary extend to the widows and families of these deceased brothers the sincere sympathy of the association, and that a copy of these resolutions be sent to their respective families and printed in our proceedings.

J. N. Penwell,
Committee.

The Secretary:—I wish to announce that if any of the members have not registered we would like to have them do so before leaving the hall. Membership cards and receipts for dues can be had at this time.

The President:—Shall we take up at this time the selection of a location for our next convention?

Mr. J. H. Markley:—I think that should be deferred until tomorrow morning.

The Secretary:—I notice that Mr. J. O. Thorn, of the C. B. & Q. R. R., is with us. He has not been out to a convention for several years. He is one of the charter members of the association and all of those present should greet him.

Meeting adjourned until 9:30 Thursday A. M.

MORNING SESSION.

Thursday, October 19, 1911.

Meeting called to order at 9:30, with President Rettinghouse in the chair.

The assistant secretary read the report of the committee on subjects for the coming year.

REPORT OF COMMITTEE ON SUBJECTS.

1. *Fireproofing Timber Trestles.
2. *Derricks and Other Appliances for Handling Material in Supply Yards.
3. *Sash,—Size and Kind of Glass for Round Houses and Shops.
4. *Concrete Tank Construction.
5. *Best and Most Economical Pumping Engines.
6. *Roofs and Roof Coverings.
7. Reinforced Concrete Culvert Pipe.
8. The Construction and Maintenance of Long Pipe Lines for Locomotive Water Supply; Intakes, Pump Pits, Reservoirs, etc.
9. The Development of Turntables to meet Operating Conditions for the Modern Locomotive, showing most Improved Practice.
10. Track Scales,—Construction and Maintenance.
11. Painting of Structural Iron or Steel, for both Bridges and Buildings.
12. Relative Merits of Brick and Concrete in Railway Buildings and Platforms.

G. W. Andrews,
A. S. Markley,
F. E. Weise,
Committee.

The report of the committee on resolutions was next presented:

REPORT OF COMMITTEE ON RESOLUTIONS.

To the Members of the American Railway Bridge and Building Association:

The committee on resolutions respectfully submits the following report:

Resolved, That the thanks of the association be extended to Mr. John Gundlach, president of the city council of St. Louis, who, in the absence of the mayor, addressed the association and tendered to us a hearty welcome to the city;

To Mr. W. M. Walker, manager of the Planters Hotel, for the excellent treatment of the members and their families;

To the daily press, for their interest in reporting our meetings;

To Mr. W. M. Camp, editor of the Railway and Engineering Review, and Mr. E. T. Howson, civil engineering editor of the Railway Age-Gazette, who reported our proceedings for those journals;

To the Pullman Co., and the various railroads, for courtesies shown our members and their respective families en route to and from the convention;

To the "Cotton Belt Route," (St. L. S. W. Ry.,) for presentng a steel engraving of the Thebes bridge to members present at the convention;

*Continued from last year.

To the harbor department of the city of St. Louis, for the use of the boat Erastus Wells, for a trip on the river;

To the members of the Railway Bridge and Building Supply Men's Association for their efforts in entertaining our members and their families;

To the officers and committees, who rendered valuable time and assistance in promoting the welfare of the association in every detail.

J. H. Markley,
James Stannard,
J. M. Staten,
Committee.

The next matter of business taken up was the election of officers for the ensuing year. The assistant secretary read the list as contained in the report of the nominating committee.

Mr. Stannard moved that the rules be suspended and that the assistant secretary cast the ballot for the officers as named.

Motion carried.

The president called attention to the harmony which prevailed in the business affairs of the association which was shown when the vote was unanimous for the selection of officers and executive members, as recommended by the report of the nominating committee.

President Rettinghouse:—It now becomes my pleasure and duty, gentlemen, to induct into office my successor, whom you have just elected, and to relinquish my seat.

I want to say to the association that it has been a pleasant duty indeed, and I want to thank each and every one of you for the hearty support that has been given me; and I hope and trust that you will do as well for my successor. Mr. Schall, you will please come forward.

I am sorry that I can not hand you the insignia of my office (referring to the gavel). Some one has been thoughtless enough to take it away from here. I hope that you may receive the hearty coöperation and support of the association and that you will fill the office with honor and dignity to yourself and the association. I now introduce to you, gentlemen, Mr. F. E. Schall, our next president (Applause).

(Mr. Rettinghouse relinquished the chair, which was taken by Mr. Schall.)

President Schall:—Fellow members of the association: you have elected me president for the coming year, and I want to thank you for the compliment and the honor you have conferred upon me. It shall be my endeavor to serve you to the best of my ability. Of course, you understand the president stands alone, just like a

general would without an army. That means that we have got to work together. This organization has attained to large membership; its reports are published broadcast and are sought by other organizations, and it behooves us to bring our reports up to the highest standard. As we increase in membership, we must enlarge and improve our reports. Now that means that we must have committees, and we must have chairmen of committees,—live chairmen I mean,—men who are willing to work. We all know that we have to work for our railway companies, and it is not a hardship. This organization has members of whom every one of us can be proud. We come here with friendship and brotherly love that cannot be surpassed by any other organization, and we must all strive with that intention. Now it will be my duty to appoint the various committees. I am not well enough acquainted with all of you, to determine on which particular subject you may do the best work for this organization, but you know, and it will be a pleasure to me if you will come to me after this meeting and suggest, either yourself or some other member, who will act as a chairman or volunteer to assist in preparing the report for the next convention on any particular subject. It will be a great help to me, and it will certainly be a benefit to the organization. It will be my endeavor to get the notices out appointing the committees as early as possible, and I would recommend that the committees get to work early. Do not let the matter delay until the latter part of the spring, when you will have something else to take up your time. Let us do this work mostly during the winter months, when we come home early and have leisure time at night; and when you send out circulars and inquiries, do not let it rest at that. They are so easily shoved out of the way. Write a post card and tickle the fellow a little, and maybe he will wake up; in that way you may be able to get what you want. I thank you (Applause). Mr. Killam, will you please step forward. You have been elected first vice president for this organization for the ensuing year. Are you willing to accept the office?

(Calls for "speech.")

Mr. Killam:—Yes sir. I will say that it gives me great pleasure to accept this honor from the association of my choice. I have been in attendance at our conventions each year since 1898, and I must endorse the sentiment that prevails in regard to the kindly interest and brotherly love that is manifested among its members. There is not a religious organization in which this is more apparent. We ought, therefore, to have the willingness to assist in the

performance of any duty which may present itself. I came over to this country a total stranger, meeting with you first at Richmond, and have met with you each year since, and I have yet to learn of the first offense that has been committed, or of any want of courtesy on the part of any member, or from any member of the Supply Men's Association. Therefore, I have great satisfaction in stating at this time that I have the association at heart. It is something to look forward to from month to month, as I go about my duties in my own country, and I can assure you that there is not a week that passes but that I think of some of these good members. It makes the year shorter and we look forward to the time when we may again see the good friends that we have so often met.

I am from the north side of the line between the two countries, and I am sorry to say that our people, in their recent election, turned down the reciprocity treaty. Nevertheless, the feeling of friendship and kindness still prevails (applause). I have often wondered, in years gone by, when there was so much bickering through the newspapers, and noticeably from some of the senators in this country, why all this should be. We are one race of people, we speak the same language and all have the same object in view respecting trade and commerce, and each the betterment of his country; and why should this bickering be? But I am glad to know that throughout the country at large agitation has died out, and there is a friendly feeling throughout both countries. As for me, I will assure you that no country, no people is more loyal to the sovereign head than are our people on the other side of the line (applause); and I want to tell you the reason why—because the mother country has forgotten the little tea party that took place in Boston in the eighteenth century and now she allows us to do just as we have a mind to do. If we want to stay, we can stay, and if we want to go, we can go; but we want to stay and work out our own destiny, according as we can see; and means are provided for us without let or hindrance from the mother country. Therefore our feelings of loyalty and friendship and love of the mother country remain the same.

Another thing, when we feel that we, on the other side of the Canadian line, are backed up by 450,000,000 of people, we feel that we are quite somebody over there; but there is really no hostile feeling over there. However, we have got to look to the future and work for the best of our country's good, which I feel that all will do. Therefore, I will bid you good-bye for the present, hoping that we shall all meet again (Applause).

The President:—Mr. J. N. Penwell: you have been elected to act as second vice president for this organization during the coming year. Are you willing to accept the office?

Mr. Penwell:—Yes sir. I would not think of taking up your time now, but I want to thank the members of this organization for the kindness that you have shown me since I have been a member, and for the honor you have conferred upon me this morning. I want to tell you how strong I feel when I follow in the footsteps of Mr. Killam. I have always regarded him as one of the strong men of this association, and with him for my leader, I feel that I am a stronger man, and I feel proud to follow in his footsteps (Applause).

Mr. Hadwen and Mr. Fullem not being present, President Schall next installed Secretary Lichty, and the members called for a speech.

The Secretary:—We are now entering upon the work of another year. It is not my intention to make complaint in regard to the duties of the secretary, but I might mention a few things wherein you may all be of some assistance in carrying on the work. It should not be forgotten that the secretary works for a railroad company, much after the same fashion that most of you do. His labors for this organization, therefore, are being done during the evenings and holidays, and at times when many men are at leisure. Do not, therefore, criticise him too strongly for not getting his work done strictly on time. There is perhaps no other way in which the members may be able to assist the secretary better than by being prompt with reports, in paying dues, sending in information, etc. I have mentioned this so often during the past few years that many of you will begin to think that it is getting to be an old story and you will pass it by without giving it a thought. I do not intend to allow it to drop, however, and will keep it up in the future as persistently as ever.

Our organization is growing all the time, and we now number about five hundred. This means something when we address mail matter to all of the members, yet it is not so much of a task if the mailing list can be kept up to date, and everything kept in order. It is pretty discouraging to learn that some member "died more than a year ago" without anyone of our members making mention of it, or to find that some member has moved to another location and has not said a word concerning it.

We shall endeavor to continue the publication of the Bulletin if the members will take some active interest in the matter and

assist in furnishing news items and information of a general nature whereby we may be enabled to make the attempt worth the effort and the expense.

I wish to emphasize one more point which was referred to by the president, and that is in regard to our committee reports. We do not give the support to our committees that we should. Most of our committees depend on the chairman to do the work. That should not be so. At the same time most of the members are very slack in furnishing information for the use of the committee when called upon to do so, even though they have plenty of such information at hand. When we look upon the work which is being done by the American Railway Engineering Association, and others, and see the results which they are accomplishing, we can appreciate the effect of united effort on the part of the committees.

Let us not forget our association as soon as we return to our homes, but keep up a lively interest in the work. If we do this we will feel all the better when the year's work is done; when we can look back and see that we have accomplished something. I am of the opinion that we would all take a livelier interest if we realized the importance of our work, and knew that our proceedings go into many libraries and institutions of learning, and are being sought by many upon the outside.

It is by constant labor, efficient and united effort and aggressive methods that we will keep up this organization and produce results that are worthy of the department that we represent. The harvest will be exactly in proportion to that which we sow. Let us all make an earnest effort and say, "I will!"

The President:—Gentlemen, it is a pleasure to me to have our secretary get up and make a speech. He does that so regularly that we are used to it, but these remarks that he has just made are exceptionally well to the point. We know that the standing of an organization rises and falls very much with the efficiency of its secretary. Therefore, I think it is up to our secretary to do all he can to make this association a success, and he undoubtedly will. Let us give him all the encouragement that he needs and he will accomplish the results.

Mr. J. H. Markley:—I enjoyed the secretary's remarks and I think that we should encourage him all we can in the publication of the Bulletin. It is always newsy and gives us the kind of information that we are glad to get. We should lend him the necessary assistance and thus encourage him to continue its publication.

The President:—The next order of business, I understand, is

the selection of a place of meeting for next year. Nominations are now in order for a meeting place for the convention of 1912. I will appoint as tellers, Geo. W. Hand, R. C. Sattley and S. C. Tanner.

Mr. Andrews:—Mr. President, I desire to place in nomination a city just south of the Mason & Dixon line, a city that is old in the history of this country and one which has sent her loyal sons out through every state in the West,—the Middle West and the Far West,—and who have been strongly instrumental in the development of that territory. It is a city which can not boast of large shops and buildings, such as we have seen in this city, but it is one in which we can show you life, geniality, happy homes and the extreme courtesy that we find in all parts of this country, and one which I believe is as fully developed as any city in the Union. We can show you good railway terminals and handsome homes; we can show you the point where, out of all due deference to my good friend Killam, and the love and courtesy that he has gained from us, meaning no offense whatever,—the point at which Francis Scott Key composed the noble national song of our nation, the spot from which he saw the grand old flag floating; we can show you the exact point at which that flag was hung; we can show you courtesy in every way and we can make you happy. I therefore nominate the good old city of Baltimore.

The Secretary:—I would like to ask Mr. Andrews whether, if we go there, we can get a convention room that will not be as noisy from the outside as this one.

Mr. Andrews:—We do not have as much noise in Baltimore as they have in St. Louis; we go about our business in a quiet and orderly manner.

The Secretary:—Some of us from Chicago should be loyal enough to present that city, but we hardly know how to say the proper thing. You have not visited us in five or six years, and five or six years ago the city of Chicago was deficient in a great many respects which go to make up an ideal convention city, notably with reference to hotel accommodations. Today Chicago is second to no city, with the possible exception of New York, in her hotel accommodations. We have hotels of every size and every price, and the Chicago Association of Commerce will absolutely guarantee a standard hotel rate to this organization. Chicago, in every respect, is an ideal convention city. We have every means of entertainment, every means of having a good time at small expense. The Association of Commerce will see that we get a good, quiet, airy

convention hall and will see to it that in every way we would be taken care of to the best advantage. We extend to you a hearty invitation to meet in the City of Chicago.

Mr. Jutton read a letter from Mr. Rear which contained a very urgent invitation to hold the next convention at Los Angeles.

Mr. W. C. Frazier:—I am the only representative here from the Pacific Coast, and I want to assure the members of this association that we would be more than glad to have you come to Los Angeles. I can also assure you that we have ample facilities for taking care of you either in Los Angeles or some of the adjoining towns—some of the beach towns, such as Long Beach where my own home is located. We have a hotel there that would be admirable for a meeting of this kind and we could care for you right royally. We have a great deal to see in that country; our transportation facilities are first class, and there is no reason why we should not be well taken care of.

"Deacon" Patterson:—I had a little experience a year ago with Brother Rear on the coast and I can assure you that if we go there, there will be something doing.

Mr. Frazier:—There will be something doing every moment, if you will come out there.

Mr. O'Neill:—I rise to second the motion that we meet at Los Angeles. These meetings are about the only vacation that many of us get during the course of the year, and I do not believe there is a member of this organization who is a man of family but would very much enjoy a trip to Los Angeles; and the opportunities for getting there are good. It takes only a few days more than to go to any other city in the United States. I want to lend my feeble voice in support of holding our next meeting at Los Angeles.

The nominations for Baltimore and Chicago were duly seconded.

The President:—While the ballots are being distributed, I want to say that your chairman is not particularly interested as to where we meet, as far as he is personally concerned. I do feel, however, that in order not to make it a hardship for anyone of this organization to attend the meeting, we should not go to the end of the earth. It will hurt this organization if we hold these meetings too far off to one side.

The result of the first ballot was as follows: Baltimore 34, Los Angeles 34, Chicago 13. According to rule, Chicago was dropped, and the second ballot resulted in the choice of Baltimore, which received 49 votes.

Baltimore was thereupon declared the meeting place for the 1912, (twenty-second) convention.

Mr. Andrews:—When the first ballot was announced, I was half glad that it was a tie, but I am more glad that you have selected Baltimore. I will do all in my power to make your visit to Baltimore a pleasant and profitable one.

Mr. A. S. Markley:—I participated at one time in Mr. Andrews' hospitality at one of our conventions in Philadelphia. There was not a thing left undone. What he has once done he can do again, and I am sure it will be a pleasure for us to go to Baltimore.

Mr. Rettinghouse:—I want to call attention to the fact that this is the first time in this convention that Mr. Andrews and Mr. Markley have agreed (Laughter).

Mr. Andrews:—You want to watch us and see how well we agree outside.

Mr. J. H. Markley:—I move that we consider, at this time, the members eligible to life membership. The secretary, I believe, has a list and has some recommendations in that direction. If he is not prepared to make the report now, he might do so a little later.

The motion was seconded.

The following members were elected to life membership: C. P. Austin, J. T. Carpenter, John Forbes, A. B. Hubbard, S. F. Patterson, James Stannard and W. W. Perry.

Mr. Patterson:—I appreciate the additional honor you have bestowed upon me in electing me a life member. I am afraid I am not worthy of it, but if you think I am, all the better. I certainly have a kindly feeling for the association and every member in it.

Mr. O'Neill:—It grieves me to hear our worthy "Deacon" express a fear that he is not worthy of the honor of life membership, and I wish he would take that back.

Mr. Patterson:—All right, I'll take it back, I assure you that the "Deacon" will accept the honor gracefully.

Mr. Rettinghouse:—I now move that we adjourn to meet at Baltimore on the third Tuesday in October, 1912.

Motion carried and meeting adjourned Thursday noon, October 19, 1911.

G. K. ANDERSON,
Stenographer.

C. A. LICHTY,
Secretary.

MEMOIR.

William Davis Walden, was born June 6, 1825, at Christchurch, Hampshire, England; died, Sept. 18, 1911, at his home at Lyons, Iowa, after a short illness resulting from old age.

For nearly half a century, until 1901, Mr. Walden was superintendent of bridges and buildings of the Iowa division of the Chicago & Northwestern Ry. Since 1901 he has been superintendent of the Mississippi River bridge, at Clinton, Ia., a less arduous task. His father was a contractor and builder in England, and the paternal grandfather was also a general contractor and builder of bridges. There is now in the possession of the Walden family the draft of a bridge built by Mr. Walden's grandfather in 1819, engraved on a silver vase, a relic which the family highly prizes.

Mr. Walden was reared and educated in his native land and for more than eight years was employed as a draftsman with architects and surveyors. He was clerk of the work of restoring Turnworth hall and the rebuilding of an old church at Maxwell, Dorsetshire. Mr. Walden arrived in New York in October, 1850. He was first employed by Montgomery Queen of Brooklyn, but he soon became associated with Mr. Henry Grimsteed, an architect of New York, under the firm name of Grimsteed & Walden, with office in Brooklyn, this connection continuing until August, 1855. As architects and superintendents of construction they had charge of the building of the Monteagle Hotel at Suspension Bridge, N. Y., for Charles B. Stuart, who at that time was consulting engineer of the Mississippi & Iowa Central R. R., and who, with others connected with the railroad company, had purchased land below the town of Lyons, Ia., for railway purposes, and had arranged to lay out a town which now forms a part of Clinton. Mr. Stuart called upon Mr. Walden in reference to a business block and hotel to be erected on the town site, and plans were drawn and arrangements made with the railway and Iowa Land Co. to erect the building, which was named the Iowa Central Hotel, now the Windsor Hotel, of which Mr. Walden had supervision. After its completion, he remained in Clinton and carried on business as an

WILLIAM DAVIS WALDEN.

architect and builder until the fall of 1859, when he went south looking for a new location. He had secured contracts and was at work on several buildings on sugar plantations south of the city of Baton Rouge, La., when the difficulty arose between the North and the South, and the parties concluded not to continue work.

After encountering some obstacles Mr. Walden returned to Clinton in 1861. Two years later, in 1863, he entered the employment of the engineering department engaged in the construction of the railway bridge crossing the main channel of the Mississippi River, which location is now owned by the Chicago & Northwestern Ry. He was also engaged in, and had charge of, the construction of various buildings erected at that time, and in 1865 he was appointed superintendent of bridges and buildings of the Iowa division, which position he held 36 years.

Mr. Walden was married in 1852 to Miss Mary Ann Bennett, also a native of Christchurch, Hampshire, England. Fourteen children were born to them, ten of whom are still living. One of his sons, W. J. Walden, is station agent at Carroll, Iowa, and another son, A. S. Walden, is a machinist in the shops at East Clinton. Until recently, another son, Henry A. Walden, was employed as chief clerk in the office of the division engineer at Boone, but he is now engaged at farming in Minnesota.

Mr. Walden was a familiar figure at many of the conventions of this association, having joined at Quebec, in 1903. He was made a life member a few years later. He was an ardent supporter of the association.

HENRY CRANE.

MEMOIR.

Henry Crane was born in Litchfield, Maine, Feb. 1, 1825; died at Janesville, Wis., July 29, 1911. He spent his early life on the little New England farm of his parents. Sept. 23, 1844, he entered the employ of Dr. L. S. Bartlett, of Kingston, N. H.

He began his railroad career in March, 1846, with the firm of Eastman, Gilmore & Co., on construction work connected with the C. & P. Ry. Later

he went with the same firm to Vermont, and was engaged on the work of the Northern Railroad until April, 1847. It was about this time that he entered the service of Amos Page, who was a contractor on the Northern Railroad. It was about the year 1851 when Mr. Page went to Chicago and contracted for some work on what is now a part of the Galena division of the Chicago and Northwestern Railway, and Mr. Crane followed him there, where he began work on the road, where he was employed during the remainder of his life, until pensioned, except for a short time in 1859-60, when he was on construction work in Texas, on the N. O. & T. Ry.

Mr. Crane was made superintendent of bridges and buildings in 1866, and his entire service with the Northwestern Line was confined within the limits of northern Illinois and eastern Wisconsin.

During Mr. Crane's long railroad career the railways of this country passed from the age of temporary construction of bridges and buildings to the most up-to-date modern construction of the present day. His career was so thoroughly interwoven with the growth of the Northwestern Ry. that he seemed to be almost a part of it. His strength of character and noble purposes all through life tell the story which kept him in one position in the same location during so many changes of officers. He was always the same, and was always found doing his duty.

Mr. Crane was married to Miss Mary Weaver, at Cary, Ill., Dec. 16, 1864, from which union were born two children, George H. Crane, of Janesville, and Mrs. Russell G. Colvin, of Everett, Wash. Mrs. Crane and these two children survive him. The funeral service was held at the residence and was conducted by Dr. Jenkin Lloyd Jones, Mr. Crane's former pastor, after which the body was transported on a special train to Milwaukee, where it was cremated.

Mr. Crane joined the American Railway Bridge and Building Association at Quebec, in 1903, and was honored by being elected to life membership.

H. P. MORRILL.

MEMOIR.

Hiram P. Morrill joined the American Railway Bridge and Building Association at its thirteenth annual convention, at Quebec, in 1903, and

was elected to life membership in 1907. He was born Sept. 10, 1842, in Canaan, Vermont, and moved to Wisconsin in 1854. He died Dec. 9, 1910, at Madison, Wis., from a complication of diseases. He was a sufferer for many years from a bronchial trouble, which was contracted from over-exposure. This was a serious handicap in the performance of his duties in later years, and finally led to his retirement at the age of about 64 years.

Mr. Morrill was for more than twenty years superintendent of bridges and buildings of a subdivision of the Madison Division of the Chicago & Northwestern Ry., extending from Milwaukee to Galena, Ill., with headquarters at Madison. He was associated with the road when it was built northward from Madison, and was intimately connected with its advancement and development until 1906, when he was retired on a pension. His quiet, unassuming manner and faithfulness to duty won for him the admiration and respect of both officers and employés of the road with which his life was so intimately connected.

In 1869 Mr. Morrill was united in marriage to Miss Emma Cadwell, of Lodi, Wis., who survives him. He also leaves a son, Fred H. Morrill, of Chicago; and a sister, Mrs. F. J. Edwards, of Milwaukee.

H. M. HENSON.

MEMOIR.

Hugh M. Henson was born at Eureka, Lyon Co., Kentucky, March 22, 1855, and died at his home in Beaumont, Texas, Feb. 5, 1911, after several months' illness, of diabetes. He received a common school education and assisted his father, who was a farmer and wood merchant, until the age of 21.

Mr. Henson began his first railroad work in April, 1876, with the contracting firm of Reed & Flannery, at Point Burnside, Ky., who were engaged on construction work with the Cincinnati Southern Ry. In 1877 he took employment with the bridge department of the Paducah & Elizabethtown Ry., which is now a part of the Illinois Central R. R., where he remained until May, 1881. He then engaged with the St. Louis, Iron Mountain & Southern Ry., in the bridge and building department, where he remained until Feb., 1882, when he accepted service with Mr. Decatur Axtell on the

construction of a portion of the Chesapeake & Ohio Ry., then known as the Richmond & Allegheny R. R.

In December, 1886, he went with the Missouri, Kansas & Texas Ry., on reconstruction work, in the vicinity of Denison, Texas. Two years later he accepted service with the Cotton Belt R. R., and continued in their employ, in the bridge and building department until May, 1892. He afterwards worked about a year with the Carter Construction Co., of St. Louis, on the construction of the Chicago, Burlington & Quincy R. R., from Old Monroe to St. Louis. He was engaged successively with the Clover Leaf, Chesapeake & Nashville (now a portion of the L. & N.), and the Denver, Enid & Gulf roads. While on the latter road he was engaged with the Bess Line Construction Co.

He held the position of superintendent of bridges and buildings on the Colorado Southern, New Orleans & Pacific Ry., in 1907-08; he was in charge of the work on the Beaumont City wharf in 1909; and in the same year was made inspector of masonry with the Santa Fe Ry., in western Texas, where he continued until the condition of his health forced him to retire a few months before his death.

March 17, 1880, Mr. Henson was married to Miss Lenora Gilbert, of Calvert, Ky., who died March 8, 1881. Ten years later he married Miss Kate McRoberts, of Fisher, Ark., who, within a year, was killed in a railroad accident on the Cotton Belt Line. He married Miss Laura B. Nickell, of Grand Rivers, Ky., June 26, 1895, who, with two children survives him —Lyman, 15 years old, and Doris, aged 13.

Mr. Henson joined the association at St. Louis in 1900, and was one of its staunch supporters. He was a member of the Masonic Order, as well as of the Odd Fellows.

T. A. CAUSEY.

MEMOIR.

T. A. Causey was born in Alton, Ill., Aug. 17, 1851, and died Dec. 21, 1910, a Sallisaw, Okla. His death resulted from pneumonia, although for

years he had suffered from heart trouble. At the time of his death he was engaged in erecting a bridge for the Kansas City Southern Ry., at Sallisaw, Okla.

Mr. Causey was a quiet man, an honorable citizen, one whom the people respected, and his death came as a shock to the community. His home was at LaCygne, Kansas. He was widely known in railroad circles, having been employed by the Kansas City, Ft. Scott & Memphis R. R. for twenty years, and for the past ten years was connected with the Kansas City Southern Ry.

He was married April 2, 1893, to Mrs. Rose Glascock, at Ft. Scott, Kans., who, with one daughter, survives him. He also leaves a sister, Mrs. J. H. Brant, in Kansas City, a brother, J. L. Causey, at Chicago, and his father, Mr. P. C. Causey, of San Jose, Cal.

Mr. Causey was a member of the Knights of Pythias lodge of Ft. Scott, and was a member of A. F. & A. M.

The funeral services were held in Kansas City, Dec. 25, 1910, conducted by the Knights of Pythias, assisted by Rev. Ambie Smith, of the Christian church, and interment took place in Forest Hill cemetery. The large attendance, and the many floral tributes, gave evidence of the love and respect of those who were in attendance at the last sad rites.

Mr. Causey was elected a member of this association at Richmond, in October, 1898.

E. C. SPAULDING.

MEMOIR.

Edmund C. Spaulding, supervisor of bridges and buildings of the Boston & Maine R. R., at St. Johnsbury, Vt.; elected a member of this association at Quebec, in 1903, died July 1, 1911, after a short illness.

Mr. Spaulding was born July 29, 1848, at Granby, Province of Quebec. His education while a boy was limited, and at the age of fifteen he began to work in a tannery, and later at harness making. After a number of years

at that vocation he went to the United States and took up carpenter work in the vicinity of Lowell and Manchester, and later at various points along Long Island Sound.

In 1879 he began his railroad career in the employ of the Baltimore & Ohio R. R., when, after a short time, his health failed and he returned to the New England Country. During the following year he took up work as a carpenter on the old Boston & Lowell R. R., when six years later he was promoted to foreman carpenter on the Passumpsic R. R. After a few years of faithful service he was made supervisor of bridges and buildings of the Passumpsic division of the Boston & Maine R. R., to which was shortly added the St. J. & L. C. R. R.

During the time that Mr. Spaulding resided at Concord, N. H., he married Miss Jennie Mitchell, who died many years ago, leaving one daughter, Jennie, who is now a teacher in the Chicago public schools. Nov. 10, 1883, he married Miss Lora Baker, of West Lebanon, N. H., who, with one son, Ora, survives him.

Mr. Spaulding was a member of the Episcopal church, and was affiliated with both the Masons and Odd Fellows. He was also connected with several railroad orders. He had a courteous and affable disposition and was kind toward all. He became efficient in the art of bridge building as well as other work which was entrusted to him in the bridge and building department of the railroad with which he was connected. In his death the railway company suffered the loss of a true and faithful employé, and the place made vacant in the home and community points to a noble career.

MEMOIR.

By C. W. Wright.

Charles F. Spencer was born at Jasper, Steuben Co., N. Y., May 23, 1868, and died April 14, 1911, at Morris Park, N. Y., after a three weeks' illness of pneumonia. The funeral services were conducted by Rev. Dickhaut, of the First Presbyterian church, Jamaica, N. Y., and interment was at Maple Grove cemetery, Richmond Hill.

He was the youngest of five sons of Milo (deceased) and Martha C. Spencer. The mother, at the age of 84, resides at Canisteo, N. Y. The three surviving brothers are Edwin, of Canisteo; and Carlisle and George, of Jasper, N. Y. The other brother, Joseph, died about three years ago, under similar circumstances, at Knoxville, Pa.

He was married March 31, 1889, at Knoxville, Pa., to Miss Hattie Hamm, who survives him. To this union was born one son, who died in infancy.

Mr. Spencer was in his early life a farmer. Later on he was engaged with the bridge department of the New York Central Lines, the constructural department of the Lackawanna Steel Co., and the United States Leather Co., of Buffalo. In 1907, he went with the Long Island R. R., as bridge inspector, and was in turn general foreman, supervisor of bridges, master carpenter and superintendent of construction, which position he held at the time of his death.

There comes a time when nearly every man needs a friend or an adviser, and Mr. Spencer was one to whom such could go and not meet with disappointment. Words are inadequate to express the true character and personality of the man. He was followed to his last resting place by a large number of railroad men of all departments, and about 300 of his own employés.

Mr. Spencer became a member of the association at the Jacksonville convention, in 1909, and after the meeting he and his wife, together with a dozen others, including the secretary and the writer, extended their trip to include Tampa, Key West, Havana, Miami, and other points.

MEMOIR.

W. B. Wood was born at Glasgow, Ky., and died at Atchison, Kansas, April 25, 1911, at the age of 36 years, after several weeks' illness of typhoid fever and other complications. Some years ago his nose was broken. This accident interfered with his breathing to such an extent that several operations were necessary, and these were made in the Missouri Pacific Hospital in St. Louis. These operations did not keep him from his work any considerable length of time, but they impaired his constitution to a noticeable extent. Pleurisy set in, and symptoms of pneumonia became apparent, and against so many odds life could not contend.

He began his railroad service in 1896, as a machine hand at Moberly, Mo., in the employ of the Wabash R. R., and in the following year became a mill hand in the car repairing department. In 1900 he was a carpenter in

W. B. WOOD.

the bridge and building department of the Missouri Pacific Ry., and then gradually worked his way up to building inspector, then to foreman, and, finally, in 1905, was made supervisor of bridges and buildings on the Omaha division, with headquarters at Atchison. This position he held at the time of his death.

Time and again, before and since his death, his associates, and the men who were under his supervision, have remarked that they never knew him to lose self-control or to appear excited. He was the same from day to day, always sympathetic and considerate of the feelings of others.

Mr. Wood was a disciplinarian, and his department never failed to deliver the results sought by his superior officers. He seems to have been a man who realized and lived up to the axiom, that more can be gained by co-

operating with men than by lashing them. He was always well poised, and quietly but firmly went about his work. In the face of perplexities common to his work he always wore a smile, although he was not given to indifference or frivolity. He was at all times a gentleman.

In 1903 he married Miss Bessie Stone, of Kansas City, who survives him, with their two children. His father resides at Independence, Mo., five sisters live in Kansas City, and a brother at Emporia, Kansas.

Mr. Wood became affiliated with this association at the Jacksonville convention, in 1909.

DANIEL ROBERTSON.
(Memoir appeared on page 26, 1910 Proceedings.)

Subject No. 1.

FIREPROOFING FOR TIMBER TRESTLES.

REPORT OF COMMITTEE

This report deals principally with the methods of preventing fires on timber trestles rather than with the methods of extinguishing the fire after it has started. The use of water barrels and such other things will not be considered here, because they do not make a bridge fireproof; they are only agencies by which the fire may be extinguished if some one gets to the bridge in time. What we want to consider herein is the manner of constructing timber trestles so that they will not ignite.

Most of the fires on bridges are started by sparks or coals from locomotives, although the source of the fire may be entirely foreign to railroad equipment. Not many bridges are destroyed by fire from outside sources, and beyond cleaning away vegetation from the vicinity of the bridge it would hardly pay to fireproof for such causes. Fire dropped from locomotives has burned many bridges and almost all such fires can be avoided by the use of a good type of fireproofing.

The question might be raised, "Does it pay to make trestles fireproof?" It is difficult to say just how much loss may result from the burning of a bridge. It will certainly be more than merely the cost of rebuilding the bridge. The greatest loss would be in case of a disastrous train wreck due to a burned bridge. If, however, the fire is discovered before a train may be wrecked, there is the delay to traffic, and the hurried rebuilding of the bridge, which costs considerably more than rebuilding under ordinary conditions.

With the primary object of protecting human lives, the Railway Commissioners of Canada require that railroads fireproof their bridges. They have issued a set of regulations, which is included in the appendix to this report, giving several methods which will be accepted by them as sufficient fire protection for timber bridges.

Timber bridges which need fireproofing most are those on high speed lines and those which may be visible to the engineman for only a short distance. The larger the bridge, the greater the need of fireproofing.

Types of fireproofing used mostly at the present time are as follows:

A. Ballasted floor pile bridges; about the same amount of ballast being placed under the tie, on the bridge, as on an embankment.
B. Metal covering on the ties.
C. Ballast covering from two to four inches thick on the ties; a wood filler being placed between the ties to support the ballast.
D. Metal covering on the caps and stringers.
E. Metal covering on the ties with two inches of ballast thereon.
F. Ordinary pile bridges built with certain kinds of treated timber.
G. Fire resisting paints.
H. Pile bridges having I-beam stringers.

The fireproof feature of ballasted floor timber trestles is not the most important reason for adopting this type of construction, and the details of such bridges can not properly be considered here, except to say that the ballast

serves as a first-class fire protection for the timber. These bridges with treated timber cost about 75 per cent more than the ordinary pile bridges.

The method of entirely covering the ties with metal is favored by many roads. It affords very good protection when the sheets are firmly attached and in good condition. If the metal used is of a poor quality and light weight, holes will soon develop and if it is not properly fastened it will soon work loose and the ends will curl up. If these things happen the covering is apt to assist ignition rather than prevent it, because the loose ends and holes will catch coals and sparks. There are many different ways of putting on this covering, the principal difference being the method of attaching the galvanized iron around the track rails. In most cases, No. 22 iron is used. To obtain the best results the metal should be securely fastened and of such a quality and weight that it will last a reasonable length of time. It should last as long as the timber in the bridge. When a good quality of No. 22 galvanized iron is used, this type costs about 75 cents per lineal foot, single track bridge.

Ballast covering over the entire deck is another type which affords good protection so long as everything is in good condition and no timber is exposed. Gravel ballast is used in most cases, although stone, slag and clay are also used to a considerable extent. The vibration will cause the ballast to bunch over the more rigid parts of the bridge, leaving some of the ties exposed. A very serious objection is that the ballast holds the moisture which causes decay in the timber. Clay affords a good protection and can be obtained in almost any locality; it is more stable under vibration than gravel, but it will hold moisture longer than the other materials. The draft of high speed trains tends to remove the ballast covering from the bridge.

The position of the filler blocks between the ties should be considered. The two extremes are,—placing the filler on the stringers and, placing it flush with top of ties. Placing the filler directly on the stringers necessitates a large amount of ballast for covering without gaining anything over a smaller amount as regards fireproofing. The decay of the timber is faster, because the contact surface between ballast and timber is larger, and the larger volume of ballast will hold more moisture. If the filler is placed flush with the top of the ties, the gravel rests on an unbroken surface and will readily move about, due to the vibration of the bridge and the draft of trains, which will leave bare spots. Probably the best way is to place the filler so that it will come about one inch below the top of the tie and then place three inches of ballast on the filler which would provide two inches of ballast above the ties. With gravel ballast such construction costs about 35 cents per lineal foot of single track bridge. Sometimes galvanized iron is placed over the guard rail in connection with the ballast covering. This adds about 15 cents per lineal foot to the cost.

Galvanized iron is placed on the tops of caps and stringers by a number of roads, the object being to protect the timber from weather as well as from fire. In this way the ties are left bare but the more important parts of the bridge are protected. It is not difficult to keep such covering in place. The metal should be of quality and weight sufficient to last as long as the timber. Using a good quality of No. 20 galvanized iron the cost is about 60 cents per lineal foot, of single track bridge.

Sometimes a covering of ballast about two inches thick is placed on the metal covering of type B. This partly overcomes some of the objections to this type, in that if some of the edges of the galvanized sheets work loose or holes develop in the metal the presence of the ballast will prevent fire. The draft caused by trains and the vibration of the bridge will cause the ballast to move about and leave bare spots as in type C. Also, the ballast will retain moisture; but this is not so serious as in type C, because the ballast does not come in contact with the timber; however, the moisture will rust the metal. The use of gravel ballast will increase the cost of type B about six cents per lineal foot.

On one road, zinc treated timber was found to be of value in resisting fire. The trestles are built in the usual way and treated timber used. This type probably adds $1.50 per lineal foot to the cost of a pile bridge and it

would not pay to use it for the one reason of fireproofing because the cheaper types would afford just as good protection.

Fire resisting paints are used to a considerable extent in the East and in Canada, with good results in most cases. If a paint exists which makes timber absolutely fireproof its employment would certainly be a first-class method of protecting bridges from fire, provided the paint would not injure the timber in any way. A double track trestle 136 feet long was painted with Clapp's Fire Resisting Paint,—the paint being applied to the top of caps and stringer and top and sides of ties and guard rails. The cost was 16⅛ cents per lineal foot, single track, or 1¼ cents per square foot of area painted. The Board of Railway Commissioners of Canada requires that if Clapp's paint is used, one coat must be applied at least every five years.

The use of I-beams for stringers reduces the probability of fire, although this can hardly be called a method of fireproofing timber trestles. Such construction costs about 20 per cent more than ordinary pile bridges.

Inspection and repairs are made more difficult by the use of types A, B, C, D and E, but with types F, G and H, accessibility to the different parts of the bridge is just as easy as for ordinary pile bridges, hence inspection and repairs are not interfered with.

Inquiries were made of all the important railroads of the United States and Canada, eighty-six in number, as to their practice of fireproofing timber trestles. Replies were received from 73, and out of these, 29 do not use any type of fireproofing.

A summary of the replies from the forty-four railroads which use one or more types, follows:

Chicago, Milwaukee & St. Paul Ry.:—Use gravel covered deck, galvanized iron covered deck and ballasted floor pile bridges. Have had good results in all cases.

Chicago Great Western R. R.:—Use ballasted floor pile bridges, and where long spans are necessary I-beams are used for stringers. Formerly used gravel covered deck but this was abandoned.

Chicago & North Western Ry.:—Use galvanized iron covered deck, but to no considerable extent. No. 16 iron is used. Have considered using a gravel covered deck.

Duluth, South Shore & Atlantic Ry.:—Use No. 24 galvanized iron on top of stringers for most bridges; also use gravel deck, filled one inch above ties, with 1 inch strip between the ties, placed "A" fashion, so as to drain to the outside.

Chicago & Alton R. R.:—Use ballasted floor pile bridges.

New York, Chicago & St. Louis Ry.:—Use sheet iron on top of stringers.

Great Northern Ry.:—Use No. 22 galvanized iron on top of ties. Formerly used gravel covering but it was discontinued.

Minneapolis, St. Paul & Sault Ste. Marie Ry.:—Use No. 28 galvanized iron on ties. Also use crushed stone covering, 5½ inches deep, 3 inches below and 2½ inches above top of ties. Prefer the galvanized iron covering and find that it is cheaper than the crushed stone deck.

Lake Shore & Michigan Southern Ry.:—Use crushed stone deck 2 to 2½ inches deep, place 3 inch strip between the ties which is flush on top with ties. Have had good results with this method. Also use ballasted floor pile bridges.

St. Louis & San Francisco R. R.:—Use No. 24 galvanized iron on stringers and caps. Also use ballasted floor pile bridges.

Northern Pacific Ry.:—Formerly used gravel covering, but this was abandoned on account of causing decay of the timber. Use No. 22 galvanized iron on stringers and caps and No. 22 galvanized iron on top of ties. Also use ballasted floor pile bridges.

Rock Island Lines:—Use ballasted floor pile bridges and gravel covered bridges. Gravel covering 3 inches thick,—1 inch below and 2 inches above top of ties; filler, 1 inch thick, between ties. Have had no fires on any of the protected bridges and intend to protect all bridges.

Missouri Pacific Ry.:—Use gravel covering. A filler 3 inches thick is placed between the ties and flush on top with ties. Gravel covering is 2 inches thick.

Illinois Central R. R.:—Use ballasted floor pile bridges. Have had good results with fire resisting paints and with zinc treated timber in pile bridges.

St. Louis Southwestern Ry.:—Use ballasted floor pile bridges and are very careful to keep vegetation and rubbish cleaned away from timber.

Chicago, Indianapolis & Louisville Ry.:—Use ballasted floor pile bridges, and have some bridges on which the stringers are covered with a heavy galvanized iron; good results in both cases.

Chicago, Burlington & Quincy R. R.:—Use No. 22 galvanized iron covering on the ties and sometimes cover this with 2 inches of gravel or cinders. Also use gravel covering 2 inches thick by placing filler 2 inches in thickness between the ties and flush on top with the ties.

Michigan Central R. R.:—Use ballasted floor pile bridges, creosoted timber, and on these bridges place No. 26 galvanized iron on top and sides of guard rail and on top of the cap where it extends out beyond the outside stringers. Also use pile bridges with I-beam stringers and are considering covering the ties on these bridges with galvanized iron, placing 2 inches of gravel on that.

Louisville & Nashville R. R.:—Use ballasted floor pile bridges with creosoted timber and on open floor pile bridges they cover the stringers and caps with No. 20 galvanized iron.

Queen & Crescent Route:—Use ballasted floor pile bridges and creosoted timber and on ordinary pile bridges they place No. 15 sheet iron on tops of stringers and caps; also use the method of placing this sheet iron on top of ties. Are considering fire walls of concrete every few hundred feet, for long trestles.

Wabash R. R.:—Use gravel covering.

Western Australian Government Railroads:—Use ballasted floor pile bridges. They find that it is very essential to keep dry grasses removed from the vicinity of bridges.

New York, New Haven & Hartford R. R.:—Cover stringers, caps and sills with galvanized iron or sheet zinc. Keep all combustible material away from bridges. On one division, previous to 1880, all timber stringers were heavily coated with lime whitewash every second year, with very good results with regard to fire prevention and timber preservation.

Boston & Albany R. R.:—Thin sheet iron is placed over tops of caps and stringers.

Delaware & Hudson R. R.:—On their Canadian lines they use Clapp's Fire Resisting Paint, complying with order of the Dominion Government.

Erie R. R.:—Cover stringers and caps with galvanized iron. Use whitewash to a small extent. Very careful to keep all vegetation cleaned away.

Lehigh Valley R. R.:—Have used galvanized iron on stringers.

Maine Central R. R.:—Recently have used Clapp's Fire Resisting Paint with such good results that it will now be used on all trestles. Keep all foreign combustible matter away from the trestles.

Boston & Maine R. R.:—Clapp's Fire Resisting Paint applied during warm weather at least once in three years to tops and sides of ties and guard rails and tops of stringers and caps. The entire right of way is kept free from all combustible material for entire length of timber bridges.

Philadelphia & Reading Ry.:—Have placed second-hand sheet iron on top of stringers with cross strips about three feet wide on top of ties, over each cap. In some cases have covered the ties with sheet iron.

Canadian Pacific Ry.:—Have whitewashed tops of stringers and caps. Have tested fire resisting paints with good results.

Baltimore & Ohio R. R.:—Have built two or three ballasted floor trestles on Southwest System. Where trestles occur on curves stringers are covered with galvanized iron. Have one bridge covered with gravel.

Mobile & Ohio R. R.:—Have ballasted floor pile bridges, which they consider the best type but are considering covering the stringers with galvanized iron or using a fire resisting paint.

Norfolk & Western Ry.:—Have one bridge covered with gravel as an experiment. They use a 2 inch filler block and 8 inches of gravel.

Cincinnati, Hamilton & Dayton Ry.:—Have used galvanized iron cover on stringers with good results.

Nashville, Chattanooga & St. Louis Ry.:—Are using ballasted floor pile bridges. On ordinary pile bridges they cover the stringers and caps with No. 22 galvanized iron.

Southern Ry.:—Are using ballasted floor pile bridges. On ordinary pile bridges they cover stringers and caps with galvanized iron.

Seaboard Air Line Ry.:—On trestles which can not be seen for a distance of 2,000 ft. in either direction, along the track, the stringers are covered with No. 20 galvanized iron. They are also using ballasted floor pile bridges.

Atchison, Topeka & Santa Fe Ry.:—Are using galvanized iron on top of stringers and caps; also have some bridges covered with gravel. Ballasted floor pile bridges with creosoted timber are used. Have tried fire resisting paints but this method has been abandoned.

Western Pacific Ry.:—Use gravel covered deck, by placing a filler block 2 inches thick between the ties. Gravel covering is 6 inches thick; the lower 4 inches being coarse gravel and the remainder fine gravel. Also have ballasted floor pile bridges.

Oregon Short Line R. R.:—Use gravel covered deck and ballasted floor pile bridges.

Houston & Texas Central R. R.:—Report poor results with fire resisting paints and with metal covering on top of ties or stringers. Are now using gravel covered deck and ballasted floor pile bridges.

Denver & Rio Grande R. R.:—Use gravel covered deck and ballasted floor pile bridges. With the gravel deck, a filler block 4 inches thick is placed between the ties and 9 inches of gravel placed on that.

Cleveland, Cincinnati, Chicago & St. Louis Ry.:—In the case of trestles on curves, stringers are covered with galvanized iron; have one bridge on which a timber filler was placed between the ties and the bridge covered with gravel.

Summary Showing the Types of Fireproofing Used on 44 Railroads.

Types Used.	No. of Roads Using.
A	6
B	2
C	3
D	5
G	4
A and D	6
A and H	1
A and C	6
A, B and D	2
A, B and C	1
A, G and F	1
A, C, and D	1
B and C	1
B, C and E	1
B and D	1
C and D	2
D and G	1

Summary of 44 Railroads, Showing Number on Which Each Type of Fireproofing is Used.

A	24
B	8
C	15
D	18
E	1
F	1
G	6
H	1

CONCLUSIONS.

Most railroads favor the ballasted floor pile bridge because it has many desirable qualities as well as being fireproof.

The protection of the timber from the weather is probably as much the reason for using type D as the fireproof feature.

Types F and H are used because with them a bridge is more permanent than the ordinary timber trestle, hence does not need so many repairs.

Types B, C, E and G are used solely to protect bridges from fire, and since type E is merely a slight modification of type B there remain only three types used exclusively for fireproofing.

As stated above, with the use of types B and C, inspection and repairs are more difficult to make than ordinarily, and this is quite important on timber structures; also when type C is used a more rigid inspection is necessary and more repairs will be needed than otherwise.

Type G is very simple and does not change the general construction of the bridge in any way. Another thing in its favor is the comparatively low cost. There is, however, some doubt as to its effectiveness, but a thorough test made under actual working conditions ought to determine whether a fire resisting paint is practicable to use for fireproofing timber trestles.

LEE JUTTON,
W. H. MOORE,
J. C. NELSON,
R. J. AREY,
Committee.

APPENDIX.

Extracts from some of the letters received are worthy of publication, and we submit as an appendix to the report:

J. C. Nelson, Engineer Maintenance of Way, Seaboard Air Line Railway: —During the past 25 years I have been continuously engaged in maintenance of way work, and during that time I have never seen or known of a trestle being fired, except from the top, therefore, I feel and believe that it is a waste of money to do anything toward protecting below the cap, other than to thoroughly clean the ground underneath the trestle of all foreign and vegetable matter. My preference of protection is the ballast floor creosoted timber trestles. They are not excessively expensive as to first cost; cost but little to maintain, and if the timber is well treated, the life should be from 35 to 50 years. The L. & N. R. R. have some creosoted timber, ballast deck trestles, which were built in 1876, and are still good. In 1881-2, the N. O. & N. E. R. R. completed a creosoted open deck trestle across Lake Ponchartrain near New Orleans, and Mr. Haugh, resident engineer of that road, told me a few months ago, that it is in perfect state of preservation, therefore, there seems to be no doubt but that ballast deck trestles built of creosoted timber, if properly treated, will last an indefinite length of time, and will effectually prevent fire. It was stated at the last meeting of the American Railway Engineering Association by the representative of some road, (I think Illinois Central) that they had experienced a fire on a ballast floor trestle, but when the gentleman was questioned it was discovered that the fire originated in a piece of open deck trestle adjoining the ballast deck, and that the fire was thus communicated to the ballast deck. I also heard of a case of fire on the Q. & C. Ry., of a ballast deck, but I investigated it and found that this was a similar case to the one above mentioned, and which in my opinion only confirms my belief and personal experience, which is that ballast floor trestles will and do effectually eliminate fires.

As to galvanized iron covering for stringers and caps: I believe that this method is a very good one, not only as a fire protection, but also as a protector of timber from decay. When the Cincinnati Southern Ry. was built, in the seventies, white pine stringers were put in a large number of trestles and all of them were fully protected with galvanized iron. In 1903, I examined some of these stringers so protected which were placed in the structures about the year 1879, and they were in good condition; in fact, many of them were so sound and clear that they were turned over to the motive power department and were sawed up for making casting patterns.

As for placing a floor between the ties and covering over with gravel or other material: I would recommend this plan, except in cases where a creosoted timber open deck trestle was in existence and in good condition. The N. O. & N. E. R. R. Lake Ponchartrain trestle is so fixed, but Mr. Haugh tells me that it is very difficult to keep the ties completely coated with the thin layer of gravel. The jar of passing trains uncovers the ties, which are to some extent liable to catch fire, and the cost of this method would be about as expensive as a regular ballast deck. For untreated timber open deck trestles, I do not think it at all permissible on account of injury to the timber, and cost of removing and replacing when renewing timbers.

I have had no experience with paint protection, nor do I know of any one that has. There are one or two paint manufacturers who make great claims for the fire resisting qualities of their paint, and they claim it is being largely used on roads in Canada and also by the New England roads. In fairness to these manufacturers, I feel that the matter is well worth investigating, as it can in a few years' time be easily demonstrated whether their paints will do what they claim.

In conclusion, I feel that the best and most effective, and in the long run the most economical method, is the creosoted timber ballast floors; and next to that, galvanized iron covering for stringers and caps.

C. F. Loweth, Chief Engineer, C. M. & St. P. Ry.:—All of the timber bridge floors on the C. M. & P. S. Ry. are fireproofed, either by being covered with sheet metal or with gravel. Sheet metal covering costs almost twice as much as the gravel covering. Both are about equally efficient, and I should say, approximately two-thirds or three-fourths of the bridges are covered with gravel, against the balance covered with sheet metal.

On the C. M. & St. P. Ry. we covered last year about ten miles of pile timber bridges according to the same plan, and about half and half.

We intend to cover at least five miles more this coming year, and will probably continue this protection in subsequent years until all timber floor bridges are protected.

We are picking out for attention first, those bridges where the speed is the greatest, and where fire would be the least likely to be seen by enginemen or by others.

We have, with few exceptions, not covered the timber floors on steel bridges for the reason that there are only the ties to burn and the floor is more open with less liability of cinders lodging.

We are using very extensively ballast floor bridges, having built over three miles of ballast floors on bridges last year on the St. Paul Lines, to say nothing about a couple of miles on the Puget Sound Line.

These ballast floors are in the form of concrete trestles and concrete slabs on steel girders, the ballast being contained in the slabs. We are also using, but to a limited extent, creosoted timber ballast floor pile bridges. We built a number of bridges of this type, although our present practice is not to use it as extensively as the others.

W. C. Smith, Chief Engr. M. of W., Nor. Pac. Ry.:—We have tried various plans along our system. Some years ago fire trouble became so bad that as a temporary expedient we stopped up the spaces between the ties on our timber bridges with fence boards and covered the deck with several inches of gravel or crushed rock. This served as a very efficient protection, but on account of the draft caused by the trains, it was necessary to frequently replace the covering.

We found, after a couple of years, that the mud deck, so-called, was hastening the decay of the superstructure of the bridges, and we decided to abandon the gravel covering and substitute galvanized iron. We placed this simply inside of the rails on some bridges, and on other districts where the fire trouble was greatest, entirely covered the surface of the bridge tops with the iron. This has proven very efficient.

We are still using the galvanized iron protection as a standard on the divisions where we burn Red Lodge coal. On some of the other divisions or on districts where fire trouble is not excessive, we simply cover the top of

the caps and stringers with the iron. This latter method, we have found, prolongs the life of the timber probably 25 per cent.

We have also a plan of a ballasted deck bridge, a few of which we have built. These have proven very efficient. The principal objection to this construction, however, is the cost of repair work, and for that reason alone we have but very few of this type. It is quite likely we will go back to the ballasted deck bridge for a number of our divisions, especially when we begin the use of treated timber for the superstructure, which use we will probably adopt in the not distant future.

A. F. Robinson, Bridge Engineer, A. T. & S. F. Ry. System:—I have tried a good many fire resisting paints on experimental bents built of creosoted material. We have found several paints which actually protected the timber work, but we found that the piling and timber had charred clear through the paint protection, so that the material would have to be repainted one, two or three coats, in order to further protect the structure. On this account we abandoned the scheme of protecting our bents with a fireproofing paint. We figure that it will cost considerably less money to keep the vegetation thoroughly cleaned from the right of way underneath the timber structures.

For a good many years we have covered the tops of our caps and stringers with galvanized iron. This has, to quite an extent, proven to be a failure, because of the wretched excuse we were able to obtain for galvanized iron. I have taken out galvanized metal sheets which had not been in service nine months and which were completely full of holes, the galvanizing having almost disappeared. The placing of sheet metal on top of the ties does not give a protection for the piling, sway bracing and under side of stringers from fire coming from vegetation on the ground underneath the bridge. This sheet metal laid on top of the ties gives us a terribly noisy structure. The maintenance of bridges fixed in this manner is expensive. I would not care to consider a scheme of this kind; it will not pay.

In regard to placing a timber floor on the ties and then covering this with a coat of gravel or crushed stone; we tried these skeleton decks in several places on the line two years ago. They protected fairly well from fire falling from passing trains, but did not give us a protection for the piling and stringers from fire that may catch on the right of way beneath the structure. I consider this a poor excuse. The maintenance is also rather expensive.

The creosoted ballasted deck pile bridge such as we have been using for years on the road gives us ample protection from fire that may fall from passing trains. It does not, however, protect the bridge in case of burning vegetation on right of way. We might try protecting the bents and lower surfaces of the stringers by the fireproof paint referred to in the first question, but we would have to count on repainting the timber work after every fire.

A. Montzheimer, Ch. Engineer, E. J. & E. Ry.:—We have never adopted any extensive plans for protecting wooden bridges from fire. As a matter of fact, we have very few wooden bridges and they are being replaced with permanent work very fast, so that in four or five years there will be no wooden bridges with the exception of the few on side tracks.

We have put water barrels on our wooden bridges and section men are instructed to keep them filled with water.

We have never used any ballasted floor on timber bridges. I have had some experience with a scheme of protecting wooden bridge stringers with galvanized steel plates, but I do not think it an unqualified success as the steel rusts very fast and it is very hard to properly test stringers with these plates on a bridge. The ballasted floor on a wooden bridge goes a long ways towards making a bridge fireproof, and in cases of important wooden bridges where it is not practicable to use ballasted floor I think I-beam stringers should be put in.

F. L. Thompson, Engr. B. & B., Illinois Central R. R.:—The percentage of fire loss on ballast floor trestles is very small, most of which is traced to incendiary origin or other foreign causes. Fire losses on open deck trestles, however, are exceedingly large on account of their exposure to coals from engine ash pans. To overcome this loss, we have tested several so-called

fireproof paints, including paints from the Clapp Fire Resisting Paint Company of Bridgeport, Conn.; also paints from the Carbolineum Wood Preserving Company of Milwaukee, Wis., with fair results.

We have used zinc treated material in quite a number of cases for open deck bridges and have found this material to be very hard to set on fire. We can get stringers, which have considerable sap and give them the zinc treatment at a cost not exceeding the cost of good live stringers and the life is about the same.

R. H. Reid, Supervisor of Bridges, L. S. & M. S. Ry.:—About the only fire protection we have in use on trestle bridges is the placing of 4 x 3 inch wooden strips about 8 ft. 8 inches long between the ties and flush with the top of the ties, getting the ends of the strips in close between the ribbon, or guard timbers as they are sometimes called, at the sides of the trestle.

Our standard ties on trestle bridges are 8 x 8 yellow pine, 10 ft. long spaced 4 in. apart, and with ribbon along the ends of the ties framed 2 in down on the ties to keep the ties in line and in place. These fire protection strips are then placed between the ties with the ends between ribbon and supported on two short blocks on each of the stringers.

This deck is then covered with fine crushed stone to a depth of about 2 or 2½ inches all the way across which prevents hot coals from reaching the timber. This has been very effective and we have had no trouble from fire where this method has been used. It is somewhat expensive, however, so we do not use it on all trestles, but on the more important ones, only where there is especial danger from fire.

In regard to ballast floor trestle, we have only one structure of this kind on our line, which was built last winter in one of our terminal yards, consisting of pile bents with caps and 8x16 stringers laid tightly together, all timber and piles being creosoted, and about 12 in. ballast on top of the stringers, forming the roadbed for the track ties.

On account of the very recent construction of this bridge, I am unable to give you any information as to its merits.

B. S. Hinckley, Engineer of Tests, N. Y. N. H. & H. R. R.:—In regard to the fire resisting properties of different kinds of timber, treated and untreated, I wish to advise as follows:

Laboratory tests were made on 6 x 6 x ¼ in. and 4 x 4 x ¼ in. slabs. and on 6 x 6 x 4 in. blocks. The slabs were tested by impinging a flame of standard size upon them, and the blocks by subjecting them to the action of live cinders.

Service tests were made on ties in the roadbed by "pulling" the fire of a locomotive and by igniting definite amounts of oil-soaked waste on the ties.

Conclusions drawn are that creosoted ties, without question, ignite more readily than untreated ties, burn more fiercely and possibly longer, but the effects are not nearly so detrimental. That is, the wood of creosoted ties is protected by a film of carbon or soot formed in the burning of the creosote, while on untreated wood the fire works in farther.

Rating shows creosoted ties first, untreated oak ties second, and untreated chestnut ties last, in order of fire-resisting qualities.

In regard to fire-resisting paints for the protection of bridge timbers and roofs, the Clapp paint proved the most satisfactory of some four or five different brands tested. The tests were severe and really did prove the efficiency of the Clapp paint.

J. B. Sheldon, Supvr. B. & B., N. Y. N. H. & H. R. R.:—On trestles, probably the best fire protection is afforded by a solid ballast floor,—first thoroughly cleaning all rubbish, grasses, weeds, etc., away from the piles at the ground. However, the ballast floor is expensive and in most places would probably not be warranted.

We have, in years past, used heavy galvanized iron on top of the stringers. This makes very good protection against fire but unless the iron is very heavy the ties will soon chafe it through and it will rust out.

From 1851-1855, the Hartford, Providence and Fishkill Railroad built a line from Providence to Waterbury, Ct., some 120 miles in length. On this

line, all frame bridge structures of truss and trestle pattern were heavily coated every second year with quicklime or common whitewash. This practice was followed for a period of about twenty-five years after erection and the losses from fire were very small. About 1880 this practice was discontinued and the results were marked increases in loss by fire. Further, the state of preservation of these structures was remarkably good, some of the Howe trusses being in actual use for more than fifty years, during which period they called for very little renewal of timber. A part of this time, however, they were reasonably well protected from the weather by housing.

From our experience and observations, we think that if all frame bridge structures were heavily coated with a lime-wash every two or three years, fire risks would be greatly reduced, while the expense would not be large.

In addition, we think that a liberal application of lime-wash is one of the best wood preservatives we have, possibly excepting creosote oils and a few other pressure-processes of preservation.

E. T. Jeans, Supt. B. & B., H. & T. C. R. R.:—I have experimented several times with so-called fireproof paint but so far have failed to find one deserving the title. Was present at a demonstration of a fireproof paint in which it was necessary to put out the fire with water to save the structure. Could see very little if any effect, due to the paint.

In my experience the use of sheet metal on top of the ties or on top of stringers has not been satisfactory. The metal protects the timber from the fire, but it allows a dry rot to form directly under the metal. It has proved of advantage in protecting the timber floors on metal bridges, as it allows rain water to get away quicker than a ballast floor, unless the ballast floor is constructed with more than ordinary care.

On this road we still have a few open deck timber trestles, and several of these have been fireproofed by building a floor of one inch lumber between the ties and then filling between the timber guard rails with gravel to a height of about one-half the height of the rail. This has proved effective as a fire preventative, as we have had no trouble from fire with any of the trestles so treated. Several of these bridges have required attention on account of using too fine a quality of gravel which sifted through the cracks in the floor. This made it necessary to renew the gravel covering. Such renewal could be prevented by using a coarse gravel, or by taking more care in the construction of the false floor.

Our standard trestle is the ballast deck. It is being used to replace all open deck structures as they require renewal. This ballast deck trestle has fifteen inches of gravel under the base of rail.

We impress it upon the section foremen that they must keep all wood and grass cleared from under timber trestles. When it is noticed that an engine is dropping fire it is immediately reported and an investigation made for defects in ash pans. All engines are inspected when arriving at roundhouse to determine condition of ash pan.

The Board of Railway Commissioners for Canada:—In pursuance of the powers conferred upon it by Sections 30 and 269 of the Railway Act, and of all other powers possessed by the Board in that behalf; and upon hearing what was alleged at the sittings of the Board held in Ottawa on the 8th day of June, 1909, by Counsel and representatives for the Canadian Northern, the Grand Trunk, and the Canadian Pacific Railway Companies, and the Michigan Central Railroad Company;

It is ordered and directed,

1. That every railway company subject to the legislative authority of the Parliament of Canada operating by steam power any railway or railways, any part or parts of which is or are constructed of, or upon, wooden trestles, the whole of which can not be seen from an approaching train for a distance of at least one thousand feet, do, during the months of May, June, July, August, September and October of each year, provide, place and keep a watchman, track-walker, fire alarm signals, ballast flooring, zinc covering over caps and intersections, or approved fireproof paint, as hereinafter directed, for the purpose of protecting the said trestles from fire; each such company having the option of adopting any of the said foregoing methods of protection.

2. That every such company shall cause to be placed and maintained at every trestle less than thirty feet in length, one barrel of a capacity of at least forty-five gallons, and on trestles of over thirty feet in length a like barrel upon or near each end, with intermediate barrels of the like capacity not more than one hundred and fifty feet apart: Provided however, that pile trestles over streams or other bodies of water need not be furnished with intermediate barrels.

3. That every such company shall cause the said barrels to be kept filled with water.

4. That every such company shall cause all brush and dead grass to be removed from beneath and around every such trestle, and shall cause its right of way crossed by such trestle to be kept free from combustible matter.

5. That, on or in the neighborhood of timber lands, or in localities distant from settlement, every such company shall cause to be provided pails for use at all trestles, and all watchmen and track-walkers shall carry such pails while upon duty at trestles.

6. That where the protection provided is by watchman or track-walker all trestles on main lines shall be inspected at least twice each twenty-four hours, at intervals of not less than eight hours, and once every twenty-four hours on branch lines.

7. That in the event of any such barrel or pail not being in good and efficient condition for holding water every such watchman or track-walker shall forthwith repair or replace the same or if it can not be done by him, he shall forthwith report such condition to his superior officer. Every such watchman or track-walker shall see that water barrels are all times kept filled to within ten inches of the top, or forthwith report same to his superior officer. Every such watchman or track-walker, whenever any such trestle is injured by fire, shall, as soon as possible thereafter, report the same to his superior officer.

8. That the fire alarm signals be equal, in the opinion of an Engineer of the Board, to the Montauk Thermostat.

9. That if fireproof paint is used, one coat thereof, at least equal to the Clapp Fireproof Paint, be applied at least every five years.

10. That the ballast flooring be of gravel and be at least equal to the standard of the flooring adopted by the Great Northern Railway Company, plans of which are on file with the Board under file No. 4966, case 1860. This flooring consists in a complete coating of gravel from beneath the head of the rail to the ties, and extends laterally from outside guardrail to outside guardrail.

11. That if zinc or galvanized iron is used, the caps, stringers, and the outside of the batter posts of every such trestle, and, if the company desires, the ties, be covered with a zinc or galvanized iron covering.

12. That every such railway company failing or neglecting to comply with any of the foregoing regulations, shall be subject to a penalty of thirty dollars.

13. That every such watchman or track-walker failing or neglecting to make inspection in accordance with the foregoing regulations, or failing or neglecting to make any of the reports herein required of him, or otherwise defaulting in any of the duties imposed upon him by this order, shall be subject to a penalty of fifteen dollars for each such failure or neglect.

14. That every such railway company shall cause every such watchman or track-walker to be furnished with a copy of this order.

15. That the Order of the Board No. 5103, dated July 30th, 1908, be, and it is hereby rescinded.

J. P. Mabee,
Chief Commissioner Board of
Railway Commissioners for Canada.

F. E. Schall, Bridge Engineer, L. V. R. R.:—This Company has not as a general rule used any protection from fire on timber trestles. We have, however, used galvanized sheet iron as a hood over the stringers; this method has been effective as far as fire protection is concerned.

We have on this road very few large trestles; for that reason the question of fire protection has not been actively considered. In my judgment a good method would be to place a $1\frac{1}{4}$ in. tongued and groved sheeting on top of the ties the full width between outside guardrails, and cover this with galvanized sheet iron; this would protect the entire deck against fire, but would be rather expensive for small trestles, but for large expensive trestles this should prove satisfactory.

Arthur Ridgway, Asst. Chief Engineer, D. & R. G. R. R.:—We have never considered the use of fire resisting paint or other liquid coating for the protection of wooden trestles against damage or loss by fire.

It has never been the practice of this company to guard against fire losses in wooden trestles by the use of sheet metal on top of ties, caps or stringers.

We have protected the greater portion of our wooden trestles by a form of construction, which we term "fire decking," and are rapidly treating the remainder in a similar manner. This is accomplished by placing wooden strips between the ties and covering the entire exposed surface of the deck, except the guard rail, with broken stone or crushed slag ballast. We have tried a number of forms of construction for this purpose, and are now adopting a style that owing to the simplicity of installation, will prove much more economical than other designs.

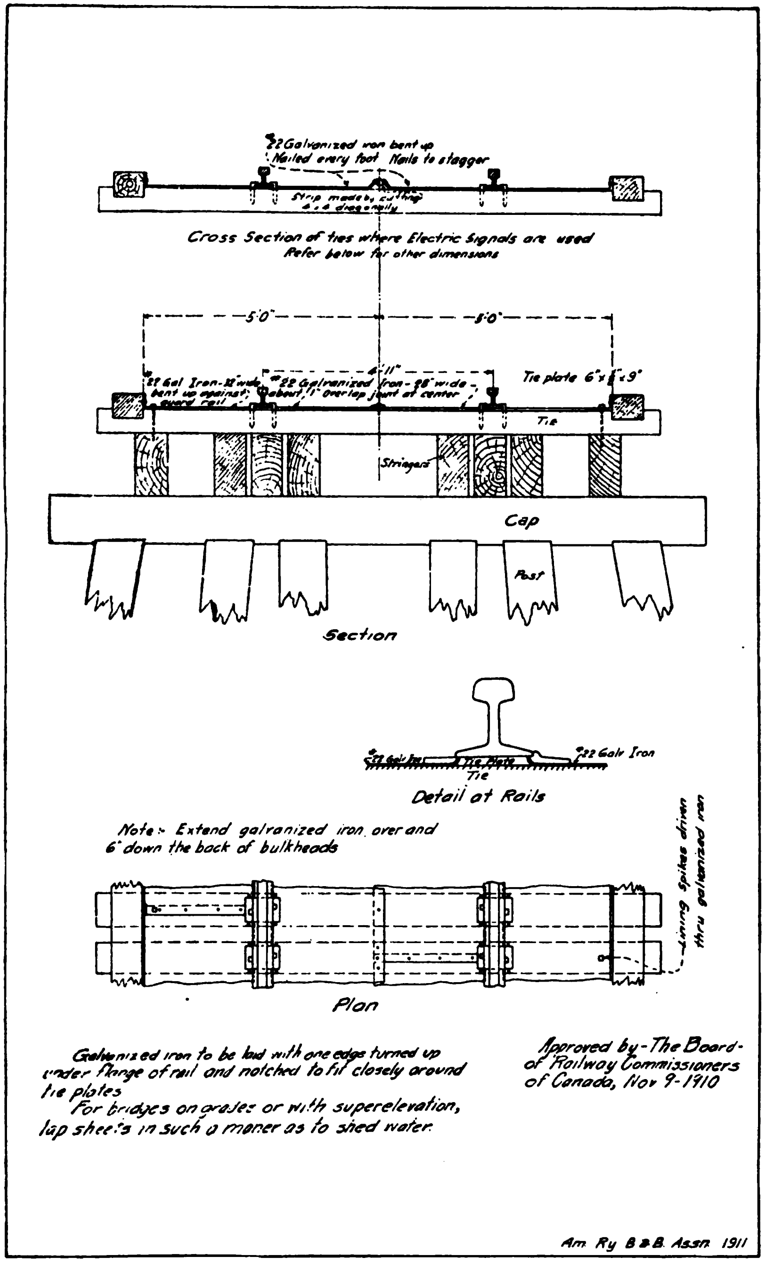
We consider that a full ballast floor pile or frame trestle will practically serve as an efficient protection against loss and damage by fire. Our standard form of construction for full ballast deck trestles, a number of panels of which have been installed for trial, has proven eminently satisfactory and serviceable. While we have never extensively renewed our bridges so as to secure this full ballast deck, yet we feel that in view of our standard plan for open floor trestle, this type of ballast deck is most economical and serviceable for our purpose. Bridges constructed in accordance with this design can easily be maintained, both as to superstructure and pile sub-structure. Our standard open floor trestle can be easily altered, so as to allow the full ballast deck construction.

W. F. Steffens, Engineer of Structures, B. & A. R. R.:—In my own practice, I have always specified thin sheet iron placed over the tops of caps and stringers, as the best possible means of protecting the timber from, not only cinders dropping from the locomotives, but also excluding water, and thus preventing decay.

Other than this, the best methods of protection from fire on trestles can be obtained by converting these structures into ballast floors, as is done extensively by the Western railroads.

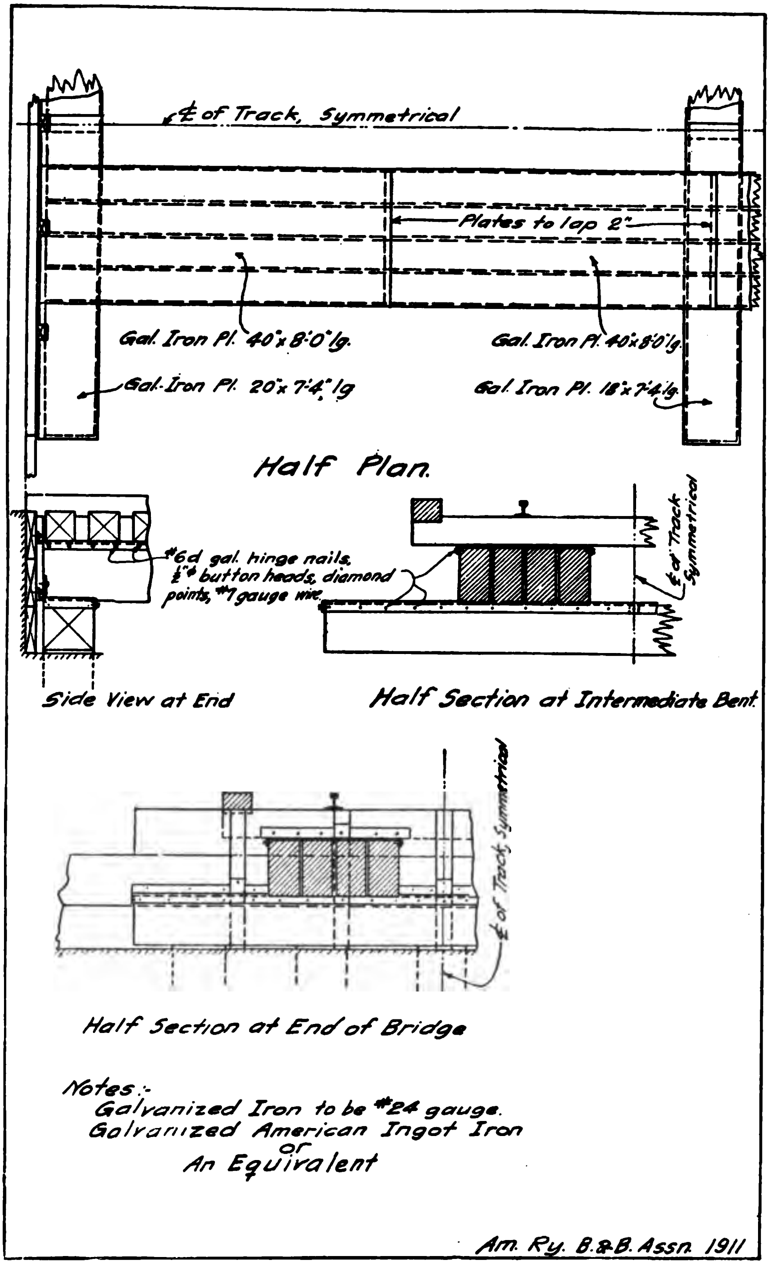
Walter H. Norris, Bridge Engineer, Maine Central R. R.:—In regard to methods used for protection of wooden trestles, I will say that until recently the Maine Central Railroad has used no method to protect its wooden trestles from fire, except to keep the trestles cleared of combustible matter, and the ground near it free from vegetation. It has also maintained barrels filled with water at each end of the bridge as well as at intermediate points on long bridges.

About two years ago, we began to treat trestles with Clapp's fire resisting paint, and are so well satisfied with the results that we are going to use it on all of our trestles. One bridge that bothered us frequently (at least every month) by catching fire from sparks and hot ashes from passing locomotives, was treated with fire resisting paint. The tops and sides of the ties, stringers and caps, and posts were given one coat last summer and we have had no trouble since.



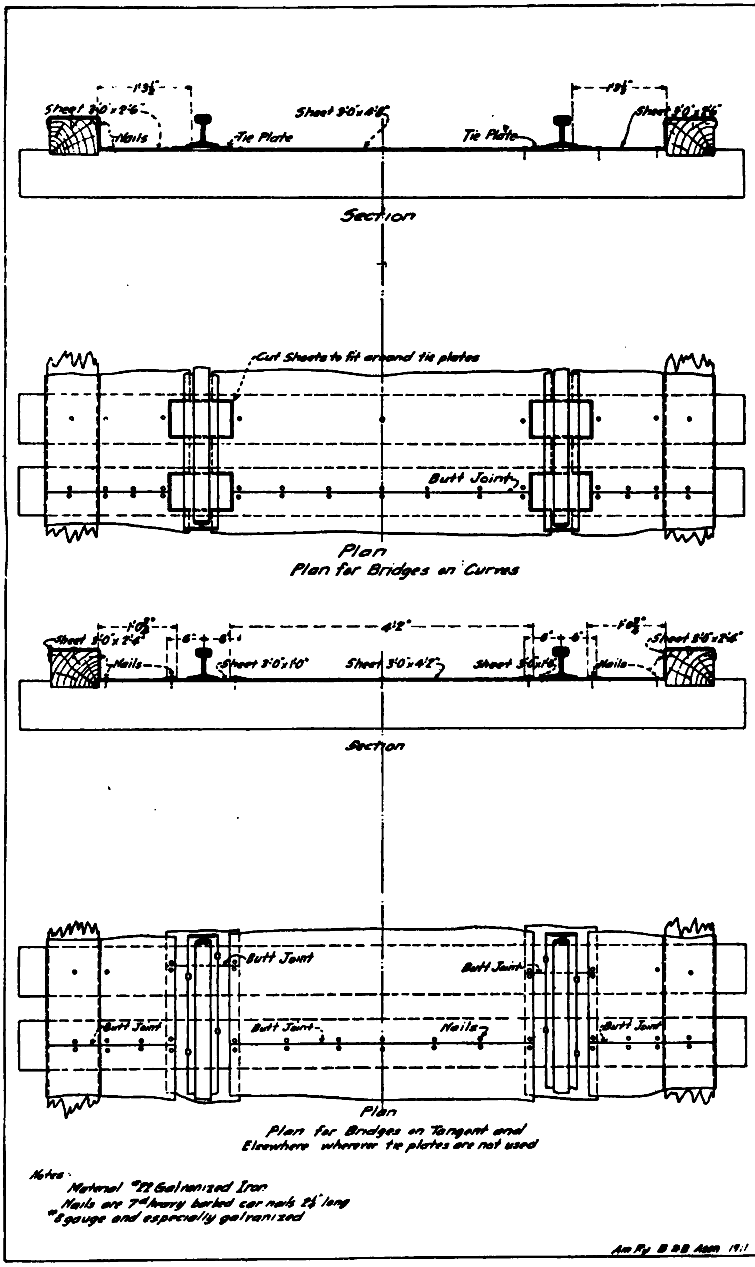
Fireproofing for Timber Trestles.

Great Northern Ry.



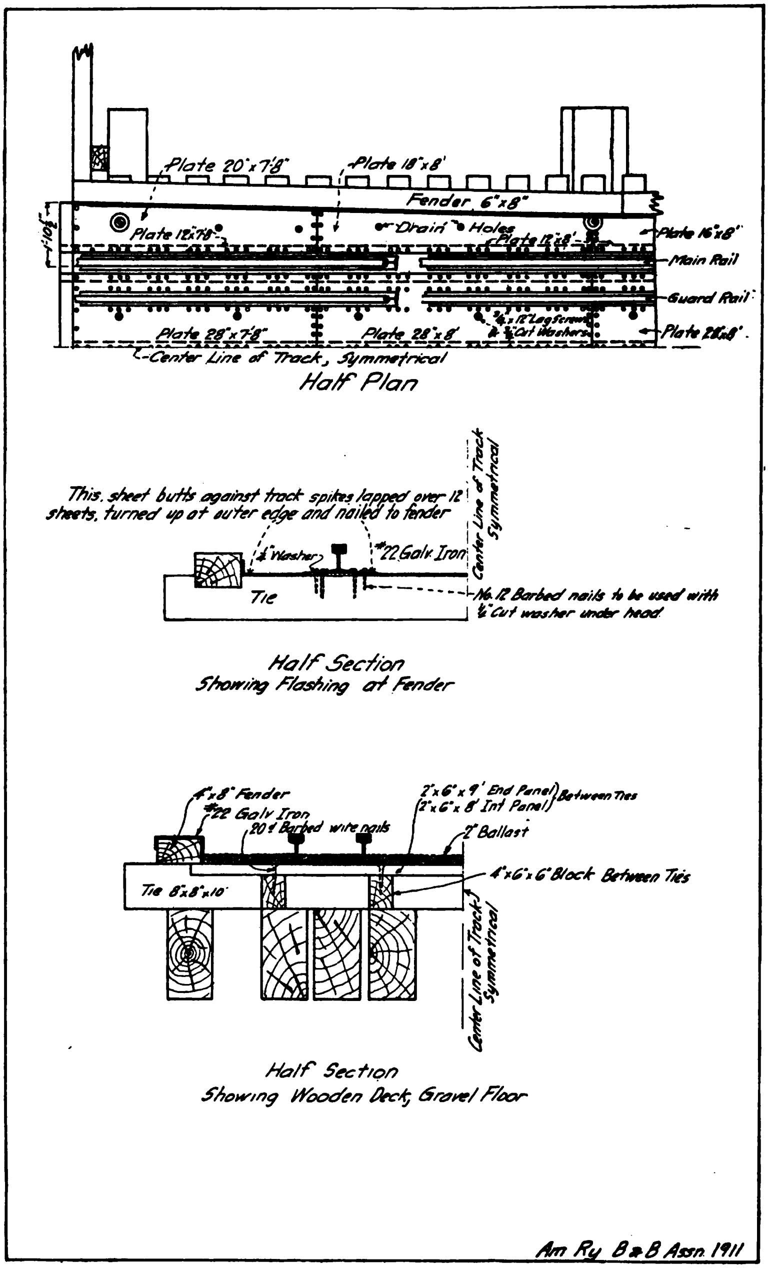
Fireproofing for Timber Trestles.

Frisco Lines.

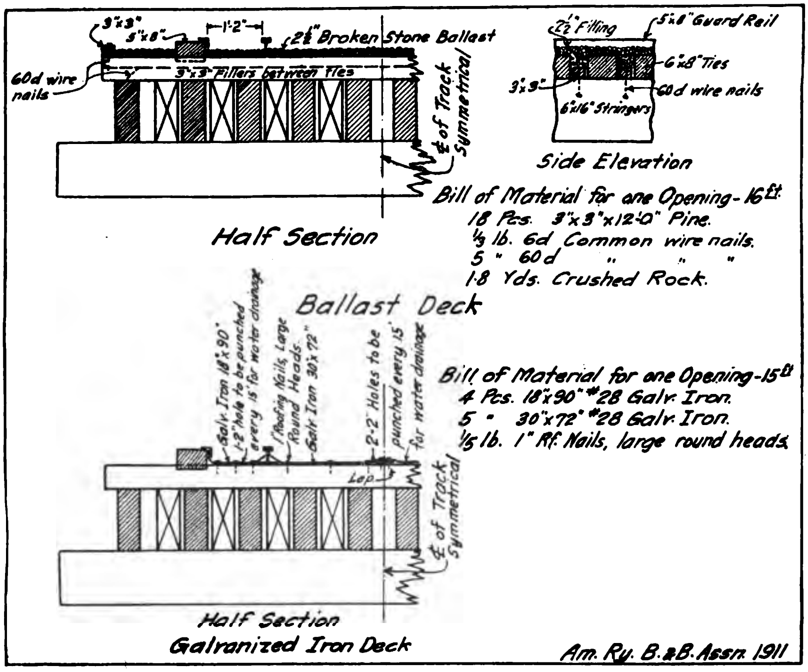


Fireproofing for Timber Trestles.

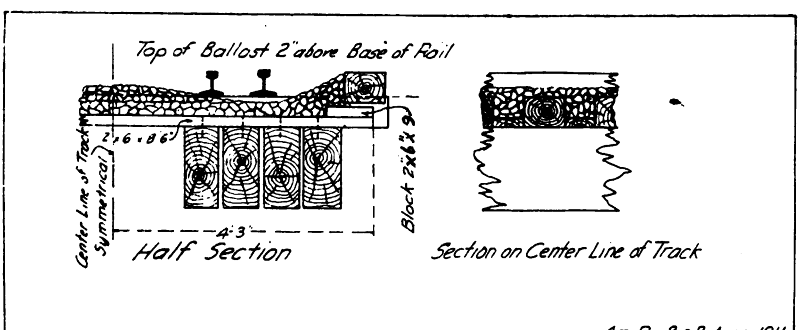
Chicago, Milwaukee & St. Paul Ry.



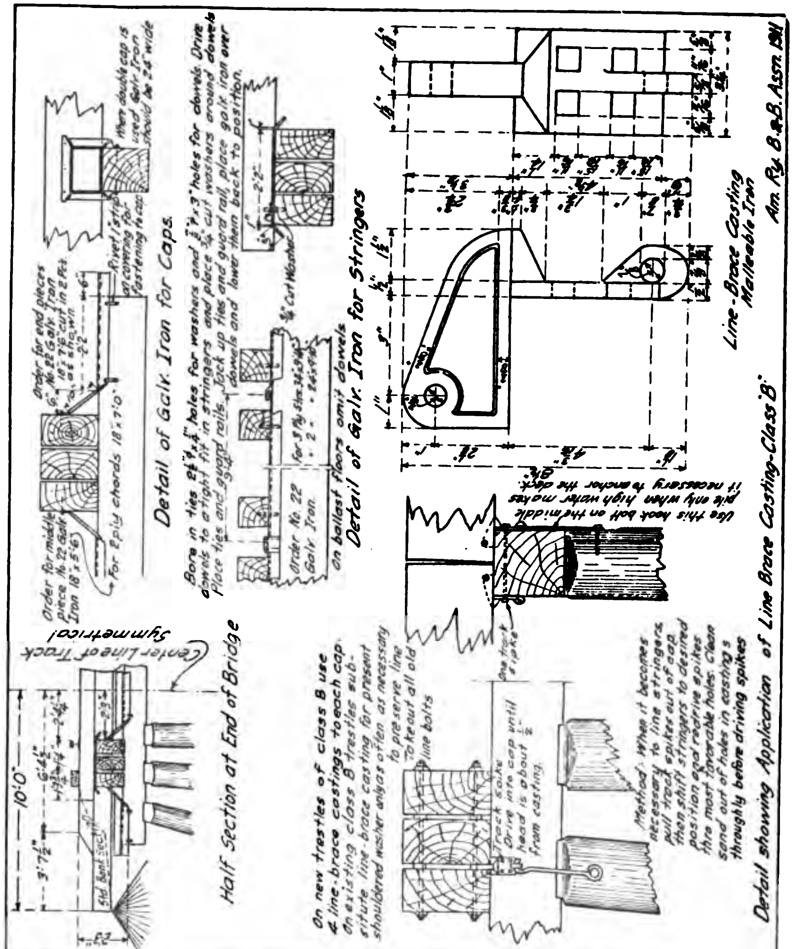
Fireproofing for Timber Trestles.
Chicago, Burlington & Quincy R. R.



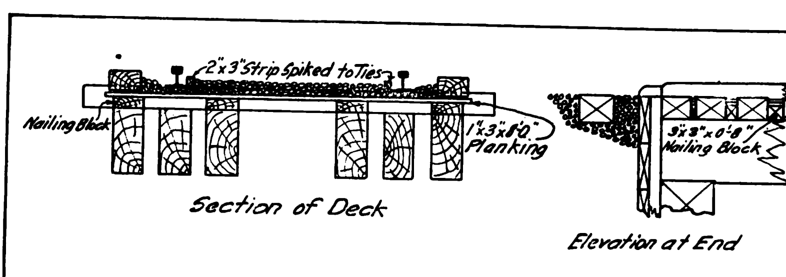
Fireproofing for Timber Trestles.
Minneapolis, St. Paul & Sault Sainte Marie Ry.



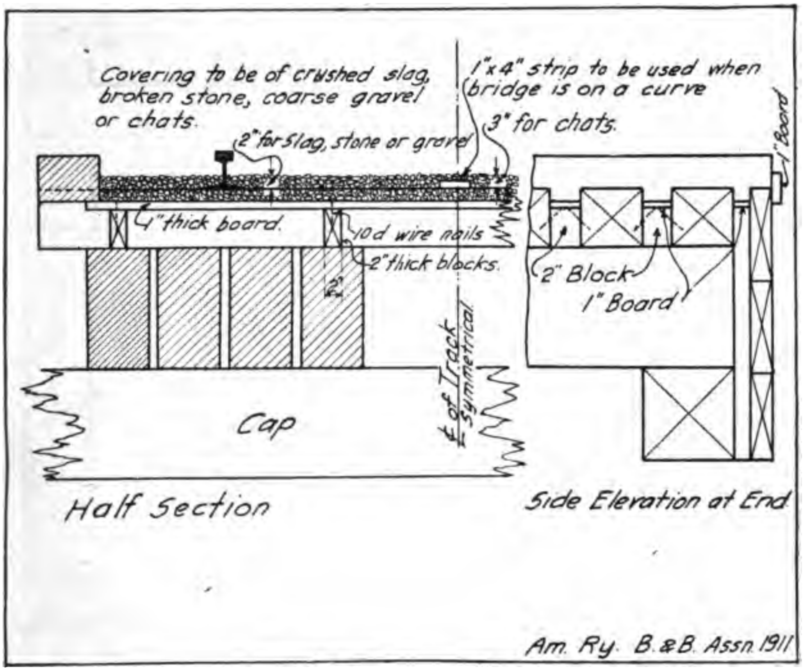
Fireproofing for Timber Trestles.
Atchison, Topeka for Santa Fe.



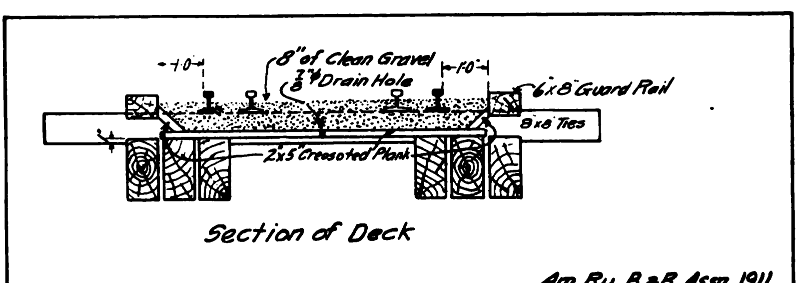
Fireproofing for Timber Trestles. Nashville, Chattanooga & St. Louis Ry.



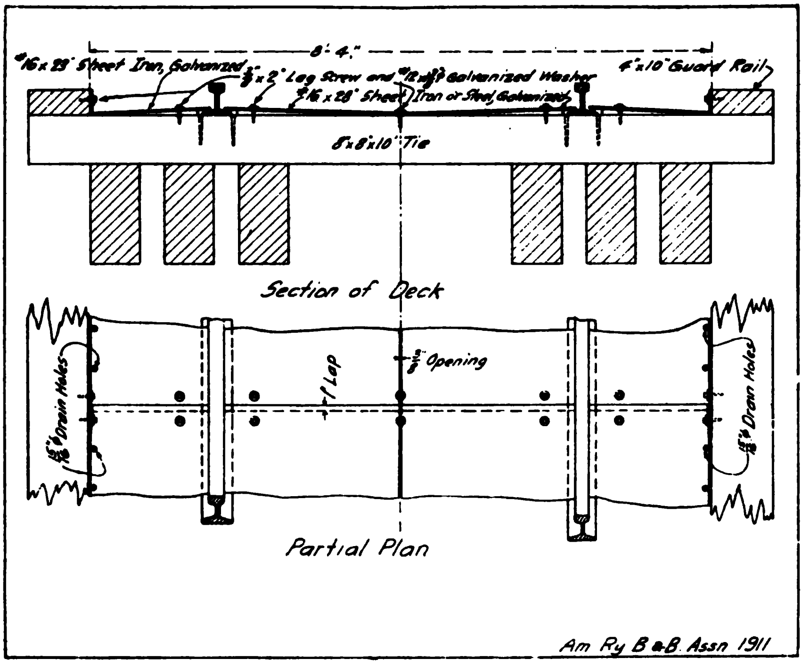
Fireproofing for Timber Trestles.
Oregon Short Line Ry.



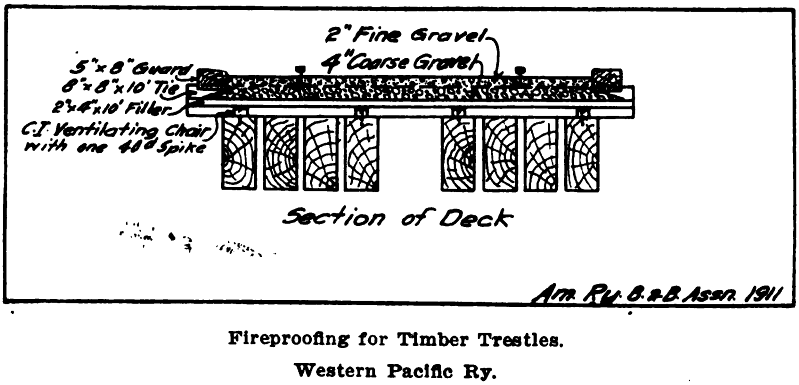
Fireproofing for Timber Trestles.
Chicago, Rock Island & Pacific Ry.



Fireproofing for Timber Trestles.
Norfolk & Western Ry.

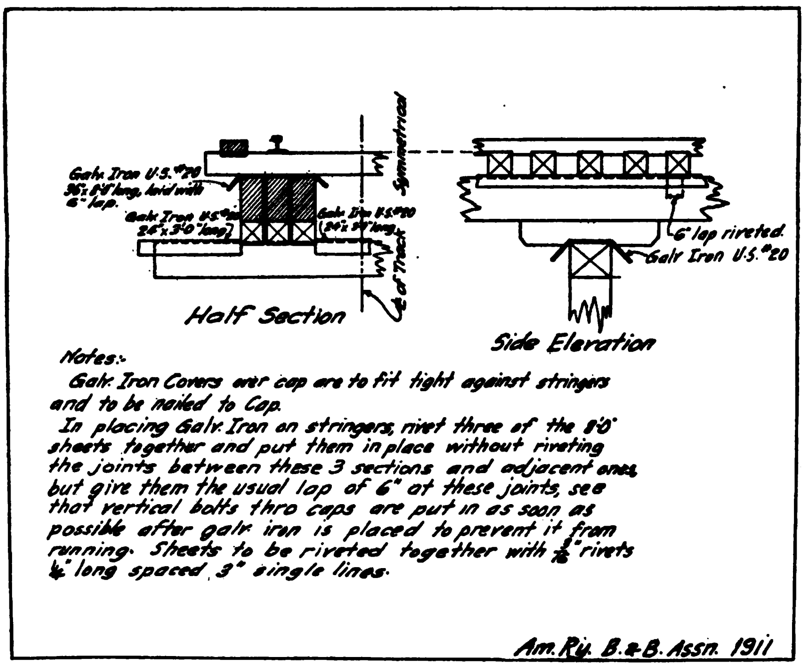


Fireproofing for Timber Trestles.
Chicago & Northwestern Ry.



Fireproofing for Timber Trestles.

Western Pacific Ry.



Fireproofing for Timber Trestles.

Louisville & Nashville R. R.

DISCUSSION.

Mr. Jutton, the chairman of the committee read the report.

The President:—Gentlemen, you have heard the report. It is now open for discussion.

Mr. A. S. Markley:—Two things are destructive to bridges which are not mentioned in the report. One of them is the carelessness with which the mechanical department maintains the fire-boxes of the locomotives. If we can prevent hot coals escaping from the fire boxes we will eliminate one of the causes. When such fires occur, attention to the fact should be referred to those who are responsible for the condition of the fire-boxes. Another cause is the presence of rotten timber in bridges. Some will maintain that they have no rotten timber in their bridges. I will venture to say that 90 per cent of the fires that occur on bridges result from rotten timber, or loose material which collects between the ties or stringers.

Fireproofing increases the cost of a bridge, and I would like to bring out, in this discussion, the point as to whether or not it increases the life of the structure; and, if so, to what extent. If, with a ballasted-floor bridge, we can get 10 to 20 per cent additional life out of the structure, over one which has not been treated in that manner then we might be justified in using such methods. It is claimed that fireproof paint is a timber preservative as well; if that is so I would like to know about how much longer it would extend the life of a bridge. This is an important factor in connection with the subject. On a large road which has a great number of temporary bridges the cost of fireproofing would amount to considerable, and, after all, it is a question in my mind as to whether it pays to do it.

Mr. Killam:—I quite agree with Mr. Markley that the dropping of fire on bridges by locomotives causes fully 90 per cent of the fires, and that rotten timber is a great source of danger. Our iron spans have hard pine decks. We have but a few pile bridges on the Intercolonial Ry., and we have never had a fire on them from rotten wood. On my first inspection I found that no attempt had been made to dress off the sap-rot. I immediately issued instructions that this should be done. I discovered some bridges which had ties that appeared so rotten as to require immediate renewal, but after trimming off the sap-rot they lasted several years longer, as well as being safe from fire. All of our bridges have water barrels sunk in the ground at the ends, and the longer structures have them stationed on the decks at intermediate points besides.

New decks, if saturated with Carbolineum Avenarius, are safe from fire for a period of four to five years. Sap-rot appears after that and care should be exercised to see that it is dressed off. We have never had a disaster on account of a burned bridge.

The President:—I would like to call upon the members who contributed to the report on this subject. We would like to hear from Mr. Hadwen, of the St. Paul road.

Mr. Hadwen:—I would suggest that we hear from Mr. Yappen instead. This subject is more directly in his line of work. There is one phase of the matter which I would like to have explained. The report mentions one road which uses zinc for a metal covering. I would like to inquire why such expensive material is used for that purpose if ordinary galvanized iron will last as long as the structure which it is placed upon for protection?

The President:—We will take up that phase of the subject a little later; may we now hear from Mr. Yappen?

Mr. Yappen:—We have a great many bridges protected with gravel, and we prepare the decks in several ways. In some instances we place the boards longitudinally over the ties and put the gravel upon them. We also make use of a method of putting inch fillers between the ties, placing them so they will come an inch below the top of the tie, and then fill over with about three inches of gravel. The latter method prevents the gravel from shifting along on the bridge. We use galvanized iron and other kinds of iron for covering, any of which I think are better than the gravel covering, especially when we consider the matter of protection from the weather. They are also of greater value as a fire preventative, for, if the gravel works off in the case of the board covering the wood is exposed to the fire which drops from locomotives.

The President:—We would like to hear from Mr. Robinson of the Chicago & North Western Ry.

Mr. Robinson:—The question of fires on bridges originating with locomotives has been up with us considerable and our superintendent of the motive power claims that they occur with a type of fire box that was required by the government; but lately they have been improved, so that the danger from fire is much less than formerly. Nearly all of our fires are caused by hot coals from locomotives.

We have a cheap method of fire protection that we have used to some extent. It consists of one inch by six inch boards which are laid longitudinally on the ties, inside and outside of the rails, and then covering them with clay or loam; but blue clay is better.

We place about three inches at the rail and four inches in the center of the track. It is packed down ordinarily with a shovel, as the men put it on, and the flanges of the wheels make a groove along the rails which carries off the water. It makes the floor practically waterproof as well as fireproof. This method costs about 37½ cents per lineal foot of bridge and is very effective.

Mr. Noon:—We use No. 24 galvanized iron over the main stringers under the ties. Our main chord is 26 inches across in width, and we use a 28 inch sheet which projects over the edge one inch on each side. We have tried gravel and clay, but with very little success. We are using what we call stamp sand, which comes from the copper stamp mines. This affords more protection to the timber than either clay or gravel, and gives good service.

The President:—That is the kind of information we want to bring out—the usefulness of the various kinds of coverings.

Mr. M. Bishop:—We use a ballasted deck, built up with treated timber. Probably ten per cent of the bridges on my division are so built. We first used ballast protection on top of the ties. We have had no trouble with fires dropping from engines in either case. That is about the extent of our fire protection.

The President:—We would like to hear from a representative of the Missouri Pacific, Mr. Smith.

Mr. C. E. Smith:—We have about five miles of trestles built on a new line in 1904 that were protected with gravel decks, and we have done nothing in the way of fire protection since until within the last three or four months. We use No. 33 gage galvanized pure iron on top of the stringers and caps and intend to keep that method going until all trestles have been protected. We are not making any special effort to protect all of them at one time, but are doing it in the ordinary course of renewals. We have about 150 miles of trestle on our line, and the fire losses run pretty high. We hope, in the course of eight or ten years, to extend this protection to all of them.

Mr. Penwell:—There is just one or two things that I want to mention in this connection. I think that the first place to begin to protect a pile or wooden bridge is at the ground, seeing that all of the combustible material is kept cleaned away from the bridge, which can be done by the section men. In the next place, bridge men are liable to be careless in removing decayed timber. They pass it by, thinking nothing of it as long as a bridge has the necessary strength. I regard it as a very important matter that the rot-

ten wood be cut away from all wooden bridges. When any portion of a piece of timber gets rotten it becomes a firetrap.

I agree with Mr. Markley that one of the most important things is to secure better attention from the mechanical department in regard to locomotive fire-boxes. We had two cases where the ash pans were actually dumped on wooden bridges, setting them on fire. I think we have a right, and I think it is perfectly consistent, to recommend to the general managers of the railroad companies that more care should be exercised in the handling of engines, to avoid the dropping of live coals on bridges. This can not be eliminated entirely, but it can be reduced to a reasonable minimum.

One more point I want to touch upon is this; if we pile clay or gravel or anything of that nature on bridges, we shorten their life. When the condition of a bridge is such that its renewal becomes necessary within six months or a year, and there is a considerable amount of rotten timbers that can not be cut away, our practice is to place a covering of mud on the ties as a temporary protection.

Another means of protection which has been mentioned is that of painting, which has the additional advantage of lengthening the life of the bridge. This method also should receive due consideration. If we get a paint or whitewash (or whatever the mixture may be) that will protect bridges from fire, I believe that it should be used. Some of the eastern roads use whitewash to good advantage. This is a very cheap method and affords good protection, but it does not look well, which is about the only objection to its use. I would, therefore, strongly recommend use of fireproof paint.

Mr. J. H. Markley:—I do not wish the committee to infer that I want to criticise their report, because it is a good one and contains much information, yet at the same time there is something lacking. One thing that appears desirable to me in conjunction with fire protection is to preserve the timber, which is of as much importance as to protect the bridge from fire. There is nothing in the report to indicate how the iron is to be held in place on the bridge to prevent it from creeping. How is it applied, under or over the ties? Does it extend under the rail?

Mr. Jutton:—I will explain that in the printed copies of this report, which we will have at hand shortly, there are thirteen drawings representative of the several types of fireproofing, showing details of construction of each type.

In regard to asking the motive power department to instruct their men to avoid dumping hot coals on bridges from the engine fire-boxes: I quite agree that this is something that should be done

and if a few men who violate such a rule were disciplined such action would have the effect of causing others to be more careful and in this way a great many fires might be avoided. The committee thought, however, that a matter of this kind should not be included in the report, except to say that coals dropped from locomotives cause the majority of fires on bridges.

It should be noticed that this report deals with fireproof construction for timber bridges, and not with the cause of fires on bridges, such as the dropping of coals by locomotives, etc.

Mr. Penwell:—I do not want the committee to understand that I am criticising the report in any manner, but I do insist that we have a right to recommend a fire preventative. As Mr. Jutton suggests, the worst enemy we have to fight is that of the reckless distribution of hot coals along the track. We can point out the causes of the fires and then recommend, so far as we are able what is necessary to protect the bridges. Therefore I think we should not hestitate to bring the matter pertaining to defective fire-boxes and ash pans to the attention of the managements.

Mr. Jutton:—Certainly; but the committee report is intended to deal with fireproofing of trestles and not with the prevention of scattering of fire. If the causes of fires on bridges could be eliminated there would be no occasion for fireproofing trestles, and in that case this subject would not be before this meeting.

Mr. A. S. Markley:—There are other members here who have their bridges fireproofed. In the absence of the printed reports, let them get up and express themselves. There is John Markley; he has had a lot of experience along that line and does not say a word.

Mr. J. H. Markley:—There are many here who are better talkers than I. I have had a great deal of experience in the way of fireproofing of bridges and protecting them from the weather as well. The first work I did of this nature was seventeen years ago. We covered only the stringers at that time, using No. 26 galvanized iron. Last spring, on account of the timber's being light for the traffic we had to put in an additional stringer. When we removed the covering from these stringers which had been on for seventeen years we found the timbers as sound as they were the day they were put in. We simply added another heavy member and then covered them again. Instead of covering the stringers only, we now cover the entire deck of the bridge with No. 22 galvanized iron.

The method of fastening the covering was as follows: At every joint we used a two inch lag screw and washer, both of which were galvanized. A slot hole was made about an inch long and half

an inch wide, allowing plenty of room for the expansion of the metal. The lag screws were not drawn down tight. On some bridges the galvanized iron is placed beneath the rails and the spikes are driven through it. I do not like that method so well.

About a year ago we built a new trestle, about 325 feet long, and on that the iron was brought up under the ball of the rail which makes it practically fireproof as well as weatherproof. It was the first bridge we covered in that way, and it seems to be very satisfactory. This work costs us about a dollar per lineal foot of bridge.

When we used the stringer covering it would last just about as long as the ties; every time we renewed the ties we renewed the metal, which was about every eight years.

Mr. J. B. Teaford:—Mr. President, I was going to be quiet for awhile and hear the older members give their experience. We use the same methods for fire protection of wooden trestles that have been mentioned here, namely, the ballasted deck, ballasted floor, and galvanized iron. We use No. 20 galvanized iron sheets over the three-ply stringers, 30 in. wide and 96 in. long; for the caps we use sheets 22 in. wide and 87 in. long. We secure those plates by bolting through the tie and the stringer, which serves as an anchor bolt against the shifting of the ties on the stringers and also to prevent the deck from floating in high water; and, as the gentleman has just remarked, it is a good protection against rain and snow, and it preserves the timbers. We have quite a number of ballasted deck bridges but for fire protection at a low cost I prefer the metal covering.

Mr. Shedd:—I want to refer to a point which was brought up this morning. Many roads have submitted plans for fire protection of bridges in connection with this report, and I would like to know why each road adopted its particular type of construction. Was it because of disastrous fires or something else? I think that the fact that a good type of fire protection also protects from the weather has had a great deal to do with the adoption of fireproof construction on the several roads. If the life of the bridge is prolonged, say 30 or 40 per cent, then the fire protection costs practically nothing, which I think is a good argument for its adoption.

I have in mind a line of road 160 miles in length, which has 16 miles of bridges about six years old. I am quite sure there has never been a fire on any bridge on this line, and I think, owing to the great cost, it would be a hard matter to get the chief engineer to approve of any type of fire protection on these bridges, for fire protection alone. But if it could be shown that the life of the

bridges would be prolonged sufficiently to pay for this fire proofing he would very likely approve of the construction.

Mr. Markley:—Just one word; I do not care to do all of the talking in connection with this subject. Only the ties, stringers and caps can be protected. We cannot protect the piling. They are left unprotected, by any of the methods that have been mentioned.

Mr. Smith:—This question was gone into at great length by the American Railway Engineering Association last March. Up to that time I had kept a record for about eighteen months of our fires, and found that about 95 per cent of them began on top, practically due to negligence, and about 5 per cent came from below. We found that it did not quite pay. From a financial standpoint it would not pay 5 per cent on the investment to fire-protect all of those bridges either with gravel or with galvanized iron, taking into account only the cost of rebuilding the trestles. We did not include what it would cost to detour trains, the overtime charges, the expense of train crews and other figures along those lines. We had no insurance figures for the possible wrecks which might cause great loss of life. At that time Mr. Courtenay, chief engineer of the Louisville & Nashville road, stated that his company had been using galvanized iron for covering caps and stringers for about twenty years; that he had taken off the iron to replace it and found stringers that were twelve and fifteen years old which were practically as good as they were when they were put in the bridges. We have on our lines a great many combination spans, the top chords of which have been covered with sheet iron for many years, and it has been a great success. From that we assumed that we were making a saving of 50 per cent at least, when we protected them with sheet iron, and on that basis it would show a profit of 20 to 30 per cent on the investment.

Mr. Aldrich:—Earlier in the discussion Mr. Hadwen inquired as to the reason for using zinc for metal covering instead of galvanized iron. I will give the reason for that. It may not be generally known that galvanized iron or steel will last only about two years in the vicinity of salt water. It would not be policy to use zinc where galvanized iron would answer the purpose, as it will in most cases.

We use metal covering only where fires are liable to occur frequently, and it gives good satisfaction. We place it above the ties on tapered blocks which slope downward from the rail toward the center of the tie. We do not permit the covering to touch the rail, for if it did it would interfere with the operation of the signals.

I think the whitewash suggestion came from the New Haven road. I have used whitewash on trestles with good success, both as a fire preventative and as a timber preservative. I think that it will increase the life of timber at least 20 per cent.

Mr. Pickering:—I have not heard any one speak about the painting of bridges for fire protection; hence I will give my experience. We have a double-track pile bridge 275 ft. in length which was painted about a year ago with a fire-resisting paint. This bridge carries on each track about 60 passenger trains per day, besides extras and freights. It took fire in September, as a result, undoubtedly of a live coal that dropped from the fire-box of a locomotive into a place between the tie and the stringer which was unprotected. The timber burned so slowly that we were able to extinguish the fire before it did any great amount of damage. I think we had a very good demonstration of the effectiveness of fire-resisting paint on that structure.

We also use whitewash and a cement wash for the same purpose. With these materials we fill cracks in the ties as well. They have proven to be very efficient. I would recommend the covering of caps and stringers with sheet iron and the painting of ties and guard rails with fire-resisting paint.

Mr. W. O. Eggleston:—If metal covering is used on stringers and caps how is the inspector to see the condition of such timbers? That brings up an important question. When timber becomes a few years old and we are a little suspicious of it, how are we to ascertain its conditon when covered in that manner?

Mr. Pickering:—I would suggest that the metal covering be made wide enough to extend over the timbers about three inches, and that it be not turned down at right angles, but simply bent at an angle of about 45 degrees. I think it would be no very difficult matter to inspect near the top of the timbers in that case.

Mr. Eggleston:—That is true for outside stringers, but where there are three or four in each chord how is the inspector going to see the condition of the inside ones?

Mr. Pickering:—I think that the metal protection over the stringers will not only act as a fire protection, but will also protect the timber from decay, so it is safe to assume that the stringers will be in good condition during the life of one set of ties. When the ties are changed the metal can be removed for repairs or renewals and then there will be abundant opportunity to inspect the condition of the stringers. Again, if the stringers become decayed on top, the constant pounding of heavy traffic, I think, will develop

kinks in the iron as the tie settles into the stringer, which would suggest a detailed inspection.

Mr. Shedd:—Some years ago the Chicago & North Western road constructed pile bridges with a sheet iron covering over the stringers and also over the caps where the stringers rested. Such construction makes inspection somewhat difficult, but our experience has been that the stringers and caps on these bridges lasted considerably longer than when not covered, and when the timber becomes poor it can be easily detected on the underside. A good way to inspect timber covered in this way is to bore into it. There is no doubt in my mind that this manner of construction adds about 25 per cent to the life of the timber.

Mr. Eggleston:—Decayed places in stringers can be detected by boring, but where metal covering is used this method is not practicable. The same is true where stringers become broken or split. For that reason I do not believe in covering stringers.

A Member:—I know of several railroad bridges that were in use for thirty years which had the stringers covered with two-ply tar paper, projecting about an inch. When these stringers were uncovered they were found to be practically as good as the day they were put in. This covering lessens the liability of fire, as well as prevents decay.

We are creosoting the under layer of planking for overhead highway bridges. We do not creosote the top layer, for it is not subjected to the hot blasts from locomotives; and, besides, it is being constantly changed out on account of wear, and not because of decay.

Mr. J. S. Robinson:—About 12 years ago, while engaged on bridge inspection, I found that a live coal got underneath the sheet iron metal covering of a pile bridge and burned the stringer nearly in two before we got the fire extinguished. The red hot coal dropped through the covering where there was a corroded spot, where the weather caused the sap wood on the top surface of the stringer to decay, and it took fire quite readily.

Last year we had a Howe truss span 120 ft. long which took fire at the bottom of a batter post. The chords of this truss had a metal covering, but the wind carried the fire right along under this protection and the entire span was destroyed.

During the last three years, on one of our lines we lost about $16,000 worth of bridges by fire. They were not protected in any manner. While our company was getting up a standard design for a covering we tried the mud and clay covering which I mentioned

before. Some of this covering has been in use for three years. This year we removed the mud from one of these bridges and found that the ties were almost as good as when we adzed off the sap-rot, and we decided that they were good for two years more, at least. I consider that method of covering cheap and efficient. It protects the timber from decay as well as from fire.

Mr. Eggleston:—A few years ago we had a fire on a 200-ft. deck truss. The ties were 8 in. by 16 in. and had been creosoted. They were set on fire from some unknown source, probably from a locomotive. The timbers were charred at least half an inch deep the entire length of the bridge, and they would have been destroyed if the fire department had not put out the fire. As it was, the heat was so intense that it ruined the rails on the bridge. Now that does not appear as if the creosoting of timber made it fire-proof.

Mr. Jutton:—In regard to the burning of crosoted timber: I wish to say that in the appendix to this report there is a letter from the engineer of tests of the New Haven road in which he gives the results of tests made on the burning of creosoted timber. He states that the presence of the creosote makes a very hot and fierce fire, and in this way hastens the destruction of the timber; hence we conclude that creosote is not beneficial as a fireproofing material.

Mr. Andrews:—I have listened with a great deal of interest both to the reading of the report and to the discussion, all of which seemed to me to be exceptionally valuable. There is one thing, however, that seems to have been overlooked which I believe is one of the best fire protection measures that we could suggest, and that is, fill the trestles. That may sound queer. I travel over a number of railroads during the year in various parts of this country, and it is astounding to me, and it is to many others, to find so many long trestles, for the existence of which there is absolutely no excuse except the first cost of a permanent structure. There are hundreds of them that could be filled and require nothing larger than a 24 in. pipe for a waterway.

Mr. A. S. Markley:—A point of order, please. We are talking about the fire-proofing of trestles.

Mr. Andrews:—I am talking about fire protection; if I get away from it call me down.

The President:—I think your information is valuable.

Mr. Andrews:—We fill a great many trestles, more for that purpose than for any other and you would be surprised if I told the number of high and long trestles we have filled in the last three years, over iron pipe as small as twenty-four inches in diameter.

There are hundreds of places where a trestle is necessary, of course, from the point of economy, but there are just as many more where there is absolutely no necessity for maintaining them. I have lately inspected a large portion of our road, and my recommendations this year will point to a number of long trestles which should be filled, and they will be filled.

In many cases trestles could be filled with material that we simply waste on the slopes. There are many trestles that could be filled leaving a 20-ft. opening; there are many that could be filled leaving a 30-ft. opening and many that could be filled leaving an opening as large as 60 ft. The first cost is heavy, but ultimately it pays. In the past few years we have filled a number of trestles where we built 60-ft. arches.

I appreciate the fact that many roads pass through country where the filling of trestles would be difficult or very expensive. but a large number also pass through a country where material available for filling is near at hand. I can only point to the city of Chicago, where railroad companies are now using sand from the hills along the lake for elevating the roads. Such material could also be used for filling trestles.

Concerning the policy of placing sheet iron on the top course of timber, I fully agree with Mr. Eggleston; I think it is a dangerous practice. It will eliminate fire danger to a certain extent, but vibration of the structure and other causes will ultimately make holes in the iron into which a hot coal may lodge and smoulder for a long time and finally a fire will break out and destroy the bridge, or a part of it.

In conclusion I will say that fire protection is a good thing, but I believe in filling trestles where it is practicable. A watchman should be employed where large trestles are maintained.

Mr. A. S. Markley:—I do not agree with Mr. Andrews.

Mr. Andrews:—I did not expect that he would.

Mr. A. S. Markley:—Where bridges are protected with metal covering the timbers will last at least fifteen or twenty years. It is the only kind of protection I would recommend for a bridge.

Mr. Schall:—We do not protect stringers on wooden trestles against fire. We have no wooden trestles on our main line, but we have them on the branches. I have nothing to say on fire protection, but I would like to know how iron covering is maintained by railroads that transport a large number of refrigerator cars. On our main line it would last about one year and then conditions would be worse than if the timbers had been unprotected. For that rea-

son we do not use any covering. We do, however, insist on cutting off all the sap-rot and keeping rubbish away from structures that might catch fire.

The President:—The point brought out by Mr. Schall is a very good one.

Mr. J. H. Markley:—When we cover the stringers of a bridge we do not apply it until the bridge is a year old. By that time the tannic acid is out of the timber or is supposed to be; then the iron does not rust so readily. I have heard some argument about the iron breaking at the edges of the ties. I have never had any such experience. Sometimes the iron will rust under the ties. When it rusts out we renew it. The cost is about 15 cents per linear foot for renewal.

Mr. Aldrich:—My experience has been that fires start between the rails resulting from coals dropped from the ash pan. I do not know of a case where we have had a fire that started outside of the rails. Salt brine drippings from refrigerator cars do no damage to metal covering between the ties. It is from ten to fifteen inches outside of the rails where the salt brine drips.

The President:—I would like to take Mr. Aldrich over the Chicago & North Western main line between Chicago and Omaha and show him the effects of salt brine between the rails; it corrodes the spikes and rails to a considerable degree on the east bound track; but it causes no trouble on the west bound track. The report, as you know, has no specific recommendations made by the committee and it is virtually a summing up of the different practices on a number of railroads. What we want to bring out is the sense of this meeting in regard to fire protection, and then make a recommendation of some kind—bring out the pros and cons, and get as much information as possible for the guidance of those who have to deal with such matters.

Mr. Smith (Mo. Pac. Ry.):—It might be a good thing to defer final action until tomorrow afternoon. We have one trestle on our system that has been painted recently with fire-resisting paint, and I understand that it has been arranged to take the delegates there to witness a fire test. Only one speaker has been able to tell us anything about fire-proofing by painting. Tomorrow afternoon all of us who go out to that bridge will perhaps know more about it than we now do.

The President:—I believe that the suggestion is a good one. We will also likely have the printed reports by that time. I think

that for those reasons it would be well to defer action on the subject until tomorrow.

TEST OF FIRE-RESISTING PAINT.

The members of the association were taken, Wednesday in a body, to witness a fire test on a Missouri Pacific Ry. bridge which had been treated with a coat of Clapp's fire-resisting paint. The test was conducted about as follows: A pile bridge, about 130 ft. long, had been treated with one coat of the fire-resisting paint by the Missouri Pacific forces, under the supervision of Mr. C. E. Smith, engineer of bridges. A locomotive was passed slowly over the bridge several times, dumping live coals as freely as possible, with the result that the fire died out without damaging the structure. This bridge was 10 or 12 years old.

A dummy span of timbers several years old had been erected on the right of way, at one side, which had been treated likewise with paint of the same kind. About this structure was scattered a bale of straw and other combustible material, which, when ignited, made a flame 10 to 15 feet in height, which blazed up through the timbers fiercely for several minutes. When the fuel had burned up the flames died out, save at two places where the stringers were partly covered with a resinous pitch. Here they burned fiercely in the breeze for over a quarter of an hour, but the flames finally died out of their own accord. There was no doubt in the minds of those present but that the paint proved itself to be a fire retardant, and the test was considered a success.

DISCUSSION CONTINUED.

Upon returning to the convention hall the discussion of the subject was resumed.

The President:—The discussion on this subject was deferred, yesterday, until after the test of the fire-resisting paint, which we have just witnessed. We will now continue the discussion.

Mr. Jutton:—Mr. Moore, one of the members of the committee, suggested to me that we get an opinion from the association as to which type of fireproofing it favors; then, with that as a basis, investigation could be continued by the committee, recommending the details of construction for such a type and report next year. I would like, therefore, to have the association indicate which type of fireproofing it favors.

The President:—The discussion had about stopped at the point where there was a divided opinion, as to whether or not it was advisable to use any fire protection at all, considering the expense. I believe it would be a good idea to find out whether or not we should make any definite recommendation as to the advisability of using fire protection.

Mr. Fake, were you here during the discussion of yesterday? If so, what are your views in regard to it?

Mr. Fake:—I was present yesterday. I have had but little experience in fire protection work. The little we are doing is at a special place where we have an approach to protect a span 45 or 50 ft. high. We built some low concrete piers about a foot above the surface of the ground, placed the bents upon them and put a ballasted floor on the trestle. We would not have gone to the expense of a ballasted floor except as a means of fire protection. It occurred to me, after today's demonstration, that the committee during another year could make examinations and tests of fire-protective paints. If they would take several temporary trestles, similar to the one we saw today, and treat them with the various fire-proof paints, and then take another one and treat it with some ordinary oil paint, say oxide of iron or something of that kind, then take one that is not treated at all and put them to test, the results would give useful information to us. I am of the opinion that it would be wise for us to undertake such action.

Mr. Stannard:—I have heard a number of men remark, since the demonstration this afternoon, that the expense would perhaps bar many railway companies from painting their bridges with such paints, even if they proved to be a success.

Mr. Penwell:—I like Mr. Fake's suggestion, and along with such tests that he has mentioned I would like to have common whitewash tried under the same conditions and compared with the more expensive paints. Whitewash sounds a little cheap, but it is just about as good as any wood preservative, and it is a protection against fire, at least to some extent. I know of some bridges in the East that have been whitewashed and have been very successfully protected against fire. I am not partial to whitewash, but, if we cannot afford to paint bridges with the more expensive fireproof paints, perhaps we can afford to cover them with whitewash.

Mr. Jutton:—I want to make a correction in regard to the figures given in this report as to the cost of applying fireproof paint. We have just seen a demonstration of the Clapp fire-resisting paint applied to one of the bridges on the Missouri Pacific Ry. The cost

of painting this single-track pile bridge was about 29 cents per lineal foot. The cost given in the report is 16 cents, which is too low. It is also stated in the report that the price per square foot is 1¼ cents, which is perhaps a little too high. One cent per square foot would be about right.

The term " fire-resisting paint" is meant to include any and all liquid coatings which have fire-resisting properties, even such as whitewash.

Mr. Fake:—I have never thought it was of very much value to apply such paints with a brush. I have always been of the opinion that if anything of that kind is applied, the timber should be dipped, or if it is painted the paint should be applied after framing and before erection. Nearly all fires in trestles, at least a large proportion of them, originate in joints which the sheet iron cover is intended to protect. It is very difficult to apply paints to the joints at the ends of the stringers and between the stringers. It is a very uncommon experience that we have a bridge catch fire from the ties. Coals will roll over into the joints, and such are the places that should be protected.

Mr. Jutton:—I would suggest that Mr. Penwell read Mr. Sheldon's letter. You will find it in the committee report.

Mr. Penwell:—I find that this letter covers what I had in mind with reference to whitewashing.

The President:—Personally, I take very kindly to the suggestion made by Mr. Fake that we, as an association, conduct some tests with the various fire-resisting paints, in order that we may have something of value for the report at the next meeting. I have no doubt but that one or more railroads will be sufficiently interested to permit of some tests being made on their road. We are somewhat in the dark now. We certainly could not, as an association, recommend consistently any one type of protection reported upon by this committee.

Mr. J. O. Thorn:—In the Spring of 1889, I built a pile trestle, 800 ft. long, across an island in Rock river about ten miles from Rock Island. At each end of this trestle there were a couple of through spans, and there was considerable switching done there. We kept bridge watchmen there, for it was a dangerous location. Partly as an experiment, partly as a preventative of fire, and partly on account of the belief that it would be a wood preservative, I applied common salt by putting a board between the ties over each bent of piles, and had the bridge watchman keep salt there all the time. I do not know how many fires were started on the ties by

engines switching there during the life of this trestle, but there were a number. However, the fire never crossed that salt, and the bridge watchmen were always able to put out a fire with a bucket or two of water. The last of those ties were removed in 1910, and they were not rotten. The grade of the bridge was changed and finally all of the piles were taken out, and they came out in a very fair state of preservation at the end of 21 years.

We have another pile trestle about a thousand feet long which is a little over eleven years old that was similarly treated. I made an examination of it a short time ago and it is a pretty good bridge yet, there being no reason why it should be taken out on account of decayed wood. I notice that in the German experiments salt is rated second as a preservative. As a fire resistant it is equal to anything I know of. We are using some galvanized iron. Personally, I am not in favor of it.

The President:—I think we have had quite a few expressions as to the advisability of using sheet iron, particularly on top of stringers and caps, some pro and some con, but I think the majority of the members present during this discussion did not seem to favor sheet iron covering of any kind except when used as a covering for the entire bridge, and that of course is a difficult matter in any automatic signal territory.

Mr. Jutton:—The Great Northern road has taken care of the question brought up by Mr. Rettinghouse in regard to placing of sheet iron on top of ties, so that it will not operate the signals in automatic signal territory. They accomplish this by using a four by four inch piece ripped diagonally. This produces a triangular block which is nailed to the ties in the center of the track for the entire length of the bridge, and the edges of the sheet iron are fastened to this block. In this way it is impossible to make a circuit as there is a slight opening in the metal near the apex of this ridge. It is true that this leaves a little unprotected space, but such a thing is necessary where there are automatic signals and trouble can scarcely result from it.

There has been some discussion about how the galvanized iron is fastened under and around the track rail. Where tie plates are used the metal should be cut so as to fit closely around the tie plates and between the ties it should extend under the track rail about a half inch and bent up slightly. Where tie plates are not used a narrow strip of metal is placed lengthwise under the rail and the other strips are connected to this narrow strip with a lap joint.

Another way, where tie plates are not used, is to bring the metal up over the track spikes to the web of the rail.

The chief engineer of the Nashville, Chattanooga & St. Louis R. R. has studied the question of the protection of timber a great deal and has worked up some very good details for placing galvanized iron on caps and stringers, and these are shown in one of the illustrations accompanying the report.

Mr. Penwell:—I move that the subject be continued another year and that the committee be instructed to make such tests as they deem wise.

Mr. O'Neill:—It does seem to me that it would be necessary for the committee to have some financial backing to make the tests properly, and I think that ought to be incorporated in the motion; that the committee should be authorized to draw on the secretary for any funds that are necessary to carry on the tests. With that added, I would be inclined to support the motion.

The President:—Will you accept that amendment, Mr. Penwell?

Mr. Penwell:—I will accept that amendment, leaving the details to the judgment of the executive committee.

Mr. O'Neill:—I support the motion.

The motion was carried.

SUBJECT NO. 3.

BEST METHOD OF NUMBERING BRIDGES.

REPORT OF COMMITTEE.

To gather data for making this report the following circular letter was sent out to many officials in charge of bridges on the various railroads:

"Will you please give the benefit of your judgment as to the best method to be followed in numbering railroad bridges, and also what is the practice on your road in this regard?

"If you have any drawings showing your method of numbering, will you please send us a blue print of same?

"We would greatly appreciate hearing from you at your early convenience."

Replies to this inquiry were received from practically everybody to whom it was sent and in the appendix is given a copy of the salient features in each of them.

After going over these replies and attempting to digest them the following facts seem to stand out:

First:—At the present time the number of roads using the mileage system is somewhat, but not greatly, in excess of the number of roads using the consecutive numbering system.

Second:—Where changes are made they are from the consecutive numbering system to the mileage numbering system.

Third:—The consensus of opinion seems to be that on a new line where a scientific system can be put in at the start the mileage system is preferable.

Fourth:—The mileage system seems to present some difficulties if applied to a large railroad with many main lines and branches. (Mr. Bland's able discussion on this subject is especially commended and the attention of members is directed to it as giving a very clear and able exposition of the subject.)

Fifth:—Where the consecutive numbering system is established on an old line of considerable mileage and many branches it seems advisable to retain it. The cost of the change is almost prohibitive. All of the officials on the road know the important bridges by their numbers, so that changes would introduce endless confusion and for a considerable time bridges would be known by either one of two widely varying numbers.

Sixth:—It has been urged against the consecutive system of numbering bridges that it gives no indication as to the location of the structures. This is readily overcome by having a proper record of bridges in the office of record, showing the stations and the mileage and indicating the numbers of the bridges in their proper relative position to these stations and mile number-posts. Mr. Killam, of the Intercolonial Railway, brings out this point very clearly. It is the system in use on the Chicago & Northwestern Railway and on practically all other roads of any considerable mileage.

When a report comes in from the field with regard to a bridge, stating the number, the report is immediately sent to the bridge department, where the bridge record books are kept, and advice can be instantly given as to where the bridge is located, with reference to the stations, on that particular line. This does not locate the bridge closer than between two mile posts and between two stations, but this is as close as can be asked from any system.

SUMMARY.

We do not believe it advisable to recommend any particular system of bridge numbering at this time. The matter has been discussed a good deal, and there are today advocates of the consecutive system as well as of the mileage system, although the former are in the minority.

The attached answers to the inquiry are recommended for the close attention of the members of the association and there is no doubt that conditions comparable to those on any railroad will be found described in one or another of the answers.

We do not believe the association, as an association, wants to recommend any particular system, nor to go on record as advocating that particular system and that system only. The compilation of the answers received makes a valuable addition to the literature on bridge numbering, and we as an association ought to be content with that.

The committee desires to thank the various gentlemen who have so kindly responded to the inquiries for information on the subject of bridge numbering and the methods in use on their various lines.

APPENDIX.

EXTRACTS FROM LETTERS RECEIVED.

J. C. Bland, Engineer of Bridges, Pennsylvania Lines:—In my opinion, the best method of numbering bridges is that wherein every bridge has a number representing a mile post plus the distance from that mile post to the center of the bridge, expressed in terms of stations; for example, a bridge is west of mile post 15 and 1,230 ft. therefrom, the number of the bridge would be 15+12, using the nearest units of 100 ft. In other words, the number of a bridge would be a mile post plus stations. This was what our people adopted many years ago, but we were then in a period of transition in bridge work (and are still). Our present method of numbering is consecutive. In a comparatively short time we will have to face this question in the case of two of our divisions, and it will probably bring up the notation which was decided upon many years ago.

It must be admitted, however, that the consecutive method of numbering has points in its favor, and quite possibly we may, when the time comes, disregard theoretic considerations and retain our present system of numbering. When the question of renumbering our bridges came up for consideration some years ago we planned to make Pittsburg the initial point from which all mileage was to be computed and our bridge signs would merely show the number of the bridge without any initial letter indicating the division, but our bridge records would have a letter which would indicate that.

In the discussion of the subject a great many difficulties presented themselves, inasmuch as some of our lines ran north and south, although the general trend of most of our lines is east and west. Again, we had difficulty in determining how to number branch lines. At that time we failed to reach a conclusion, and after making an estimate of the cost the matter was deferred. It has come up for reconsideration at intervals, and we will have to come to some conclusion soon for two of our divisions which have been very much built over. Whether to number consecutively, as is our present

practice, or go to the decimal system, adopted years ago, is still undecided. Personally I am not as keen now for the decimal numbering as I was ten years ago, and it is largely because our lines are so situated that to carry out that system fully would lead us into some absurdities.

The principal objection to the decimal system of numbering is that it gives no clue to the number of bridges on any particular division, or on the entire system, whereas, the consecutive method does.

After all, I think the numbering of bridges is an arbitrary matter, which we become accustomed to, like any other matter, and when once learned is pretty hard to replace. The merits of the decimal system of numbering are many, but in reality I think are largely theoretical. If the matter were left entirely in my hands I would adhere to the consecutive numbering system.

I. L. Simmons, Bridge Engineer, Rock Island Lines:—The practice on our road at present is to number the bridges according to mile post location. For instance, if a bridge is located at mile post 24.1, we call that bridge No. 241, designating at the same time the division or branch on which it is located. All of our bridges, therefore, have whole numbers, but the bridge record shows their location according to miles and hundredths. We do not number pipe culverts or reinforced concrete culverts.

It is not our plan to use a prefix indicating the various divisions or branches. The bridges on some of the lines taken over by the Rock Island system are designated by a prefix, because such was the practice of those lines, but when the new number boards are put on there will be no prefix. We simply refer to a bridge on a branch line as being, for instance, "Bridge No. 1043, Ardmore Line, Indian Territory division."

A. F. Robinson, Bridge Engineer, Atchison, Topeka & Santa Fe Ry.:—Our old method was to number the bridges consecutively, beginning at one end of the line. Thus, the bridges between Chicago and Kansas City were numbered from 1 to 818, beginning with No. 1 at Chicago. The bridges on the Pekin branch were numbered from 1 upward, No. 1 being the first bridge out from Streator on this branch.

On our Coast Lines we use a letter prefix and the mile: "A15," "B15," "C15," etc. A would designate the first bridge after passing mile post 15. B the second, and so on.

On other portions of the system the letters are used as a suffix, and the bridges after leaving mile post 15 would read "15A," "15B," "15C," etc.. until reaching mile post 16, then would read "16A," "16B," and so on. I like the latter system better than that which is used on the Coast Lines.

G. W. Rear, General Bridge Inspector, Southern Pacific Co.:—In considering this subject, one naturally asks, "Why number the bridges at all?" Is it not a fact that all the larger bridges are commonly known by their names and not by their numbers? Every man on the Southern Pacific knows where Big Cañon trestle is, but it is doubtful if half a dozen know its number. This being the case, it follows that numbers are used mainly to identify the less important structures, and consequently the number should convey some idea as to location. It is doubtful if it is wise to have the number also designate the style of the structure.

There are two styles of numbering which follow out this idea:

1st, Numbering from each mile post, showing mile and hundredths, thus—1234.56.

2nd, Numbering from each mile post, showing mile and a letter, thus—1234A, 1234B, etc.

The decimal system has an advantage in that the distance from the mile post is given and structures can be filled or new ones put in without revising the bridge numbers. The disadvantage is mainly that if a board is lost the section foreman will not be able to tell the exact number. Some one else must then locate the number, and in making an inspection it is not easy to discover omissions. It is also difficult to read a long number, where a railroad has several thousand miles of track. Another disadvantage is that when an engineer finds a small structure riding badly he usually waits until he gets to the next structure and reports the number back from the second one. Mistakes often occur in that way.

The main disadvantage of the letter system is that the numbers have to be changed every time a structure is removed or a new one inserted.

The advantages of the letter system are that the numbers are easily read, it being only necessary to catch the letter; and when boards are lost it is easy to replace or repaint them by referring back to the last number or mile post.

Personally, I recommend that structures be numbered with the mile number, with a letter to designate the order in which opening comes beyond the mile board. The numbers should include all openings through the embankment which terminate on the company's property; also overhead structures which are maintained by the railroad. This method eliminates sewers, water pipes, etc., which are continuous, and overhead structures for which the company is not responsible. I would not number surface or slat cattle guards, but would number pit guards, pipe culverts, etc.

Wherever possible the number should be painted on the structure itself, as on the end post of through bridges and on the bulkhead of trestles and bridges suitably constructed.

A. B. Ilsly, Bridge Engineer, Southern Railway:—On our road the number gives the mile post location, and the letter, which may be either a prefix or a suffix, indicates the line or division. Our main line bridges are numbered without prefix or suffix letters, and in a general way, the bridges on the lines in the east have prefixes, while those in the west have suffixes.

We have more lines than there are letters in the alphabet, and the suffixes and prefixes in these cases are selected without any particular system.

Many of the lines have letters which refer to local names. For instance, the Aiken branch, is designed by the prefix "AB"; Evansville branch by the suffix "EB;" the Middlesboro branch by the suffix "CG," because this line passes through Cumberland Gap.

W. F. Steffens, Engineer of Structures, Boston & Albany R. R.:—The Boston & Albany and the New York Central main line use the consecutive system of numbering bridges. The New York Central tried the mileage basis for a short time and pronounced it a failure. My personal preference has always been for consecutive system coupled with mile post record of it in the office. Perhaps this preference may be prejudice, but our section men and bridge employés were thoroughly disheartened when the mileage system was tried, because it was often a case of remembering five figures, whereas, with the consecutive system, using a prefix to designate the branch from the main line, only two figures, or, at most, three figures, were necessary. Even the stenographers were constantly twisting the decimals in transcribing them in correspondence and records.

W. S. Bouton, Engineer of Bridges, Baltimore & Ohio R. R.:—The practice on the Baltimore & Ohio R. R. has been to number the bridges on each division independently. In general, this numbering has been serial, using the lower numbers for the main line of the division and a separate hundred for the bridges on each branch of the division. In case there is any change of line or of division terminals, which changes the mileage of the division or eliminates one or more bridges, this system permits the dropping out of the numbers without affecting the remaining numbers. Additional bridges are numbered by using fractions. This system of numbering has an advantage where such changes are likely to occur.

Where the mileage of a division is not likely to change, because of revision of line or change of terminals, I believe that the mileage system is the most satisfactory, giving each bridge the number corresponding to mile and tenth of mile, thus showing its location from the terminal. This system has been in use on five divisions of this road for some time, and has recently been extended over a sixth division.

The mileage system of bridge numbering on this road follows the mileage of the division in which it is employed. On the Chicago division, for instance, where the division mileage starts with "O" at Chicago Junction and runs west to Chicago, the first bridge is numbered "$0/4$," showing that it is 0.4 of a mile west of the division terminal.

On the Indiana and Illinois divisions, which extend from Cincinnati to East St. Louis, the mileage is continuous over the two divisions, starting with "O" at Cincinnati and running to 336 miles at East St. Louis. The first bridge west of Cincinnati on the Indiana division is numbered "1-29." The first bridge on the Illinois division is numbered "170-04," being 0.8 mile west of the Eastern division terminal, which is 16.6 miles west of Cincinnati.

This latter system, however, was in use prior to the absorption of this territory by the Baltimore & Ohio R. R. and the numbering which existed at the time of the absorption has not been disturbed. In extending the use of the mileage system of numbering it is the intention to adhere to the system already adopted on the Chicago division, as mentioned above.

C. H. Cartlidge, Bridge Engineer, Chicago, Burlington & Quincy R. R.:—It is my firm conviction, after some twenty-five years of experience, that the double decimal system of numbering is the best. This involves the presence of mile posts, because the bridge numbers follow the mileage, and the location of bridges and culverts is determined by two places of decimals. This avoids confusion when bridges or culverts are located in close proximity and also makes possible the removal of the bridge without requiring the changing of all the numbers in the mile or the records in the office, except so far as the bridge is concerned.

The fact that a certain number is reported by an officer of a given division is sufficient to identify the bridge. On branches of division in question the system provides for the use of a letter designating the branch, the letter being placed at the beginning of the number. This is not universally used, however, as we have found it sufficient to use the number and designate the branch as well. Of course the ideal way is to use the letter as suggested.

A. E. Killam, Inspector of Bridges & Buildings, Intercolonial Ry. of Canada:—There is some difference of opinion as to the best method of numbering bridges. Some think best to give the number a letter prefix or suffix to designate the various classes of structures.

When I came to the Intercolonial Ry. that road had no system of numbering bridges. After I became acquainted with the state of affairs I adopted a system of my own which gives good satisfaction. I began at the west end of the line and numbered the bridges consecutively to the next station; then started in again with No. 1 and numbered consecutively until the next station was reached, and so on. The mile posts were also noted, and the structures are therefore located both by mile post and station. Sheets were then prepared, numbered consecutively and assembled in book form, making a register which is kept on file in the bridge engineer's office. Each division foreman is furnished with a note book, compiled from this register, for use in making inspection. The register shows the dates of inspection for the last twelve years of each bridge.

A system was devised in the chief engineer's office by a Danish engineer, designating spans by letters, but was not adopted.

John A. Bohland, Bridge Engineer, Great Northern Railway:—Bridges are numbered in numerical order in direction away from St. Paul, except in case of our Duluth line, where the reverse order is used. On branch lines new series are started from junction points. In this way we have several bridges of the same number and it is always necessary, in referring to bridges by number, to give the location or line upon which they occur. We, however, do not find this objectionable, and I consider it good practice, even if the bridge numbers are so arranged as to show the line.

We have considered various systems of numbering, but no action has ever been taken to make the change. For example, we have considered the mileage system with number corresponding to mile post and tenth; and the symbol system with the letter to indicate the line. I consider the mile-post system a good one, but this is again complicated by branch lines, which would require symbols.

F. L. Thompson, Engineer B. & B., Illinois Central R. R.:—The scheme used for numbering bridges on this road is known as the mileage system. On the main line, from Chicago to New Orleans, bridges are numbered be-

ginning with zero at Chicago and running to 912 at New Orleans. Any bridge on a given mile has the mile number, then a dash, and after the dash the nearest hundredth of a mile at which the bridge is located. For example, a bridge one-half mile south of Mile-Post 250 would be written "250—50." No prefix is used on the line from Chicago to New Orleans. Other main lines and branches have the same letter prefix as that used by the transportation department in the location of stations. By the use of this system, when the number of a bridge is given, its exact location should be readily determined.

E. B. Ashby, Chief Engineer, Lehigh Valley R. R.:—Our present practice is to number bridges in accordance with the mile within which they are located. For instance, the first bridge on Mile 130 would be numbered "130;" the second, "130-A;" the third, "130-B." The culverts and pipes are numbered in a similar manner, and to distinguish them from the bridges, a cipher is placed in front of the number. All openings above five feet clear span are called bridges; all openings below five feet clear span are called culverts.

For branch lines, to avoid duplication of numbers, an initial is prefixed to the numbers; for instance, for the Flemington branch the letter "F" precedes the number.

We think very well of numbering bridges according to the mile and decimal parts of a mile. For instance, bridge No. 100.05; No. 100.2, etc., and we are now looking into this manner of numbering.

H. Ibsen, Bridge Engineer, New York Central Lines:—In my opinion the best method is to number the bridges according to the mileage, locating the bridge to the nearest hundredth of a mile, taking the mileage as running from the starting point of each division. For example: Our main line numbering runs from Detroit to Chicago and from Detroit to Buffalo. Our numbering on branches runs according to the mileage from the main line diversion point.

Up to about 1898, we used the consecutive method of numbering on our road, giving each bridge a consecutive number starting from division headquarters. We found this unsatisfactory, as we often had to put in new openings and then had to use half numbers or renumber our bridges entirely. Numbering by mileage leads to no trouble in this respect, and we find it much easier to locate a bridge definitely, so that everybody can find it when work is ordered, or when slow orders are requested for any reason. The numbering, however, exists only on paper and in our records.

We have several times contemplated getting up numbers to put at our bridges, but so far it has been considered to be too expensive, and has been put off until some other time, except as to stenciling the mileage on the bond timber or guard rail of wooden bridges, and on the side of steel bridges when they are being painted.

C. E. Smith, Bridge Engineer, Missouri Pacific Ry.:—The present practice on our line is very unsatisfactory, the bridges being numbered from one up, on the individual lines, the numbers being the same as those given the bridges when the lines were originally built. There are many bridges having the same number on each division, and they must be identified by referring to the lines on which they are located.

I have not been able to arrive at a satisfactory method of numbering bridges on railroads having many divisions or branch lines, but I presume some system of mile-post numbering could be worked out that would be satisfactory.

A. W. Carpenter, Engineer of Structures, New York Central & Hudson River R. R.:—We tried at one time to adopt the mileage system of numbering bridges but found it unsatisfactory for the following reasons:

1st: It made great confusion in our records, the bridges having been numbered consecutively and no changes having been made in the numbering for many years.

2nd: The mileage system was found to be changeable, varying with any change in the length of line caused by change in alinement. For instance, we built a cut-off at a point near New York City which shortened the line three-quarters of a mile. This changed all the mileage on the main line between this point and Buffalo practically the entire length.

I believe personally in the consecutive system of numbering as being the most satisfactory.

Openings four feet and under, of any character have no number, unless a regular consecutive number now exists for them, in which event this regular consecutive number is maintained. Where the present number may be a sub-number, as "A-1a," the number can be dropped. Where there are openings over four feet which at present have no number they can be given a sub-number, as A-1a.

All pipes, box culverts, small arches and other openings under four feet are scheduled by showing their relative position and mile post location, but they are not given a number.

W. H. Moore, Engineer of Bridges, New York, New Haven & Hartford R. R.:—The system of numbering bridges—whether railroad or overhead—on the New Haven Line, is the mileage system, the zero point being taken at the commencement of each division or branch and numbering the bridges consecutively in accordance with their distance, in miles and hundredths of a mile.

Before this system was adopted there was no uniformity of numbering on the different properties which were absorbed to make the New Haven road as it now exists, and this led to great confusion. We have found that the uniform numbering by mileage works out very well, and is perfectly elastic. The number locates the bridge, making it very convenient for men sent out to examine any particular structure.

R. H. Reid, Supervisor of Bridges, Lake Shore & Michigan Southern Ry.:—The system which we now have in use on this road is the old-fashioned one of consecutive numbering, starting from one end of the division, or branch,—generally the west end of main-line divisions and the end of branches where they connect with the main line. One difficulty in this system of numbering is that when new structures are built between the older ones, fractional numbers are introduced which in some cases get very numerous and rather lead to confusion; and also, if any of the regular structures are abandoned the number has to be carried along with the statement that the structure has been abandoned, in order to keep the consecutive numbers. This system of numbering does not show the location of the bridge from either end of the branch, and does not indicate to train dispatchers or superintendents just where the structures are.

A better system, which we are gradually introducing on our lines, and have already in use on two of our branches, is what we call the mileage system of numbering, that is, giving each structure a number which shows its distance in miles and hundredths from some definite point; in the case of the two branches the distance being from their main line connection. One of the advantages of this system is that any one hearing a bridge or culvert number knows just where it is located. Also, if a new structure is built, its location automatically determines its number.

There are other systems of numbering, one of which is the mile and letter system, viz.: all bridges in the first mile would be as follows: "1-A;" "1-B;" "1-C;" "1-D," etc.; in the second mile, "2-A;" "2-B," etc. Any extra structures built between existing structures, would necessarily have fractional numbers with this system, and I do not think it is as good as either of those which we have in use. I consider the mileage system of numbers the best, taking everything into conisderation.

On the main line the mileage can be calculated from one end of the line or from one end of a division, but, preferably, on ordinary railroads, from one end of the line. On branches, the mileage can be calculated from the point where the branch leaves the main line, or, if desirable, from the other end of the branch, although I prefer the former.

As additional structures may be required on account of track elevation, separation of grades for highways and other purposes, there is always a number available for them without having to use fractions. The numbers should show the mile and hundredths. In this way structures 53 feet or more apart will have definite numbers, and it is rarely that bridge structures or culverts are nearer together than this.

We have three branches numbered with miles and hundredths, the remainder of the line being numbered in the old-fashioned way with consecutive numbers, but we are in hope of gradually changing from these to the mileage system. The great difficulty in our case is that all of our structures for years back have been carried on our account books and on the auditor's books under the old numbers, and a change to new numbers of any kind on a road as old as this is quite a serious matter. This makes it the more essential to start right on new roads and new branches.

J. E. Crawford, Bridge Engineer, Norfolk & Western Ry.:—The system used on this road is to start at one terminal on the main line and number bridges straight through to the other terminal. Each branch is given a separate series of numbers, and allowance is made for possible extensions. If it becomes necessary at a later date to place undercrossings or other additional bridges between any two bridges, the new bridge is given the number of the one next to it, with the addition of a letter. We find this system to be satisfactory.

About ten years ago the Association of Railway Superintendents of Bridges and Buildings, of which our general bridge inspector is a member, threshed over this question of bridge numbers very thoroughly, and decided that the system which we are using was the most satisfactory one.

An alternative method is to number the bridges by mile-post location. This method is open to objection owing to the many duplications of numbers and because it is necessary to prefix a letter or name to denote the branch or division.

H. E. Stevens, Bridge Engineer, Northern Pacific Ry.:—I am sorry to say that the system of numbering bridges on this road is far from being a model one. At the time the line was built the system followed was to number all bridges consecutively, beginning with number one at the east end of each division. The culverts took the number of the next bridge east of them with an alphabetical suffix.

We have cases where culverts between two bridges run clear through the alphabet and start in again "A" and a numerical suffix. As time passed and division points were changed, new divisions added, and bridges were filled and new bridges put in, timber bridges replaced with culverts, etc., the system of numbering finally became so involved that it was difficult to locate a bridge by the number unless some other information was added.

Some years ago, therefore, it was decided to renumber the bridges, and a system based on the mile posts was adopted. Under this system a bridge takes the number of the next mile post east, a decimal and number being added to indicate the number of the bridge in particular. For instance, the third bridge between mile posts 132 and 133 would be numbered 132.3. Culverts are not taken into account in the numbering. This system was put into force on three or four divisions, but was found objectionable because of the difficulty of numbering a bridge when one was placed between two existing bridges; also when a bridge was filled and replaced with a culvert its number under this system would disappear. Notwithstanding, it is a great improvement over the old system.

In my opinion, bridges should be numbered with reference to the easterly mile post, plus the number of hundreds of feet it lies west of said mile post. The number should be written in a circle with the mile post number on the upper half and the number of hundreds of feet on the lower half, with a horizontal line between.

P. B. Motley, Engineer of Bridges, Canadian Pacific Ry.:—I have to state that our bridges are always numbered according to mileage, and the mileage is based on engine runs called "subdivisions" which are in turn parts of divisions.

J. B. Maddock, Engineer B. & B., Central of Georgia Ry.:—Where there is more than one bridge to a tenth of a mile the nearest hundredth should also be used. We do not mark the designation of branch lines on the number block of bridge, but specify it in reports as "A&B" line or "C&D" line.

C. Chandler, Engineer B. & B., Chicago Great Western R. R.:—The advantage of the mile and decimal numbering system is that an employé of the road is ordinarily familiar with the location by miles from some given point, and on seeing the mile number on the bridge immediately associates this bridge with a certain place, the distance of which from Chicago is known. It also enables one, in case of a telegraphic report of an accident by fire or otherwise, to immediately locate the point at which the accident occurred without having to refer to any other data than the nearest town to the bridge number by mile. This system of numbering is used by the C. G. W. R. R.

L. D. Hadwen, Engineer Masonry Construction, C. M. & St. P. Ry.:—On our line bridges and culverts are designated by numbers, having a letter prefixed indicating the division on which they are located; the bridges being designated by even numbers and culverts by odd numbers. The numbering on each division runs westward, time card directions being followed; the first bridge being designated as No. 2 and the first culvert as No. 1. These numbers are assigned to the structures on completion of a line, and additional bridges or culverts that are built later are given fractional numbers showing their position relative to the older structures. Both main line and branches have the same prefix letter and on the Chicago, Milwaukee & Puget Sound line double letters are used to avoid confusion with those on the parent line.

While the above method has its objections, in that it does not locate the position of the structure as is done in a decimal system where the number shows time card location of the structure, yet, on account of the labor involved in the change on over 9,000 miles of track, it has been considered inexpedient to adopt a new method.

The number boards used by us heretofore have been attached to ends of bridges. Small boards nailed horizontally to the right-of-way fence post adjacent to the ends of culverts are used for this class of opening.

Personally, I consider that a system of numbering which designates the location of a bridge with reference to its actual position on the profile is most desirable, especially if used with a letter prefix for each division. It is increasingly difficult to separate openings under track into bridges and culverts, for many structures might be considered as belonging to either class; moreover, bridges are continually being replaced with culverts. This fact makes it desirable to have the openings numbered without reference to their character and entirely by their location.

A. E. Deal, Bridge Engineer, Delaware, Lackawanna & Western R. R.:—In cases where we have bridges coming close together, on different branches, at the same mile post, it is understood that when reports are made regarding these bridges they are to state whether the bridge is on the main line, or if on a division, and the name of the division.

J. G. Gwyn, Chief Engineer, Denver & Rio Grande R. R.:—I would advise that if a new bridge opening should be created on our main line between mile post 274-A and 274-B it would necessitate renumbering of all the bridges between the new structure and mile post 275.

While it is possible to get along without the suffixes "E," "W" and "S" for bridges on double track and sidings, I nevertheless regard them as essential. It is easy enough in describing a bridge in correspondence to state whether it is on a siding, or on which main track it is located, yet, I feel that each bridge should have a distinct number. It is partially, therefore, due to the facility of adding these letters to the number plate on the bridge that we adhere to the practice.

I am also of the opinion that these suffixes eliminate considerable confusion and discrepancy in bridge and building foremen reporting work on their monthly job lists, for, with the system as we have it, it is almost impossible for work reports or records to come to us without definite information as to just which structure is meant.

This system has been in use on our lines for many years, and while it is possible, perhaps, to devise some other system which will answer equally well, yet, I do not believe there is one which is better for practical purposes in keeping clear, concise and comprehensive records of our bridges.

W. H. Wilkinson, Inspector of Bridges, Erie R. R.:—The simplest way to designate bridges is to number them consecutively from one up, for each division, but this has its drawbacks, particularly when an opening is filled, or a new one installed, etc. In addition, this system does not permit of readily locating a bridge unless the nearest station is shown.

In my opinion, the best method is that in which bridges are numbered according to mile post location. For instance, if a bridge is located three-quarters of a mile west of mile post 300, on blank division, the number would be 300.75. While it would be more desirable to show the numbering to the nearest tenth, this does not in some cases permit of an accurate location where bridges exist close together; and for this reason hundredths should be used. Numbers should be stenciled on the nearest telegraph pole, or on the structure.

This system is in vogue on the Erie Railroad and is giving satisfaction, particularly for locating structures in the field. Some definite arrangement, such as considering the east or west end of a bridge in numbering, should be decided upon, on account of the great length of some structures. Such a system is perfectly elastic, and, in conjunction with the time table, gives a ready means of accurately locating any bridge. For branch lines, the mile posts usually begin at the junction with the main line, and the system is thus applicable to all cases.

There is only one instance where there would be ambiguity, and that is in case of a revision in alinement, where the old line is kept in use. In such a case, of course, if the mile posts start at the junction point on the cut-off, they would not coincide with the old line mile post where the cut-off again joins the same. This difficulty can be overcome by installing the mile posts as in branch lines, and then going back to the main line mileage where the cut-off again joins the main system. In all the above-mentioned systems it is necessary, of course, to state the number and the division, particularly in the case of branch lines and cut-offs, as will be evident.

J. M. Staten, General Inspector of Bridges, Chesapeake & Ohio Ry.:—I am still of the same opinion as when I made a report on this subject in 1895. We put numbers only on openings of ten feet and over. We never number anything like a box or arch culvert, no matter what the length may be. Number blocks have numbers on each side, which shows the same from each direction. Ten bridges may be on a territory covering one mile, and if one of these should be dispensed with it will not affect the remainder, or if a new opening be created within the mile, the fraction of a mile will designate it. This is a big advantage over the old conventional way of numbering. I don't know the actual cost of number blocks, but they are not expensive. I must emphatically denounce the numbering of all waterways. This seems utterly useless to me. All railroads are endeavoring to fill openings of less than ten feet, by using old iron and scraps of steel rail, and ballasting over them so that they are then looked after by the section men, who are responsible for them when they cease to be bridges.

Howard G. Kelley, Chief Engineer, Grand Trunk Ry. System:—This company is following its old practice of numbering bridges consecutively, without regard to mileage, and where additional bridges or openings are constructed they are designated by the letters "A," "B," etc.

Personally, I believe the best method of numbering bridges is by mileage and tenths, without necessarily complicating the reading on the number board by the insertion of any letter or other designated mark for the division or district in which it occurs. Ordinarily, on a large system, no man can carry in his mind all of the letters which designate a division or district, nor can he remember the various bridges by number, except the most important ones.

The designation by mileage and tenths immediately places the location of the bridge clearly in one's mind, and the report in an emergency case with respect to any particular bridge would designate the division or district upon which it is located.

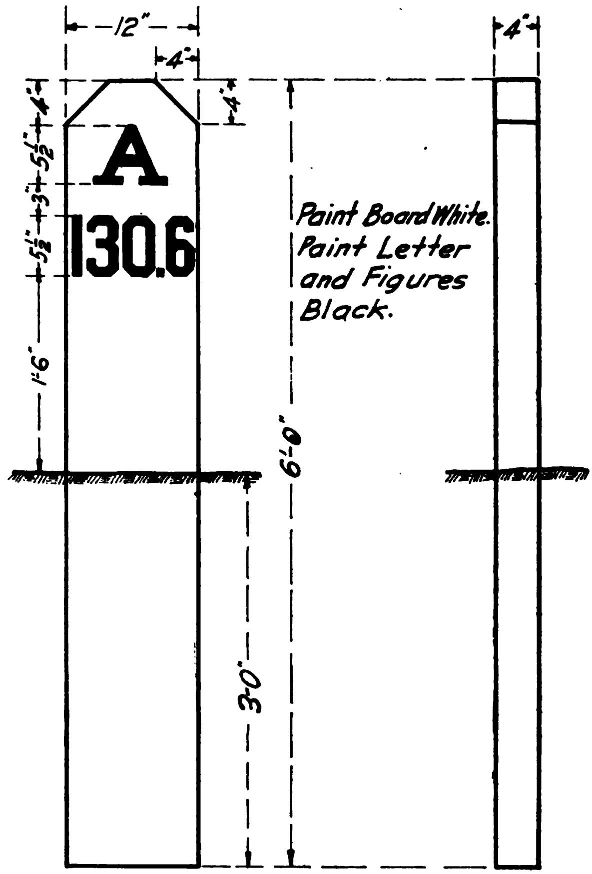
Wm. Graham, Civil Engineer, Baltimore:—If the conditions on a railway regarding bridges were to remain stationary for long periods of time,

probably the best and simplest system would be straight consecutive numbers. This stationary condition, however, practically never obtains. The typical railway is in a continual state of evolution, due to changes in alinement and grade, replacement of temporary by permanent structures, diversion of streams, new railway crossings, both electric and steam; opening of streets, highways and private crossings; elimination of grade crossings; track elevation and depression; new industrial crossings; new navigation, drainage canals, etc. These changing conditions are best met by the mileage system of numbering bridges and other structures.

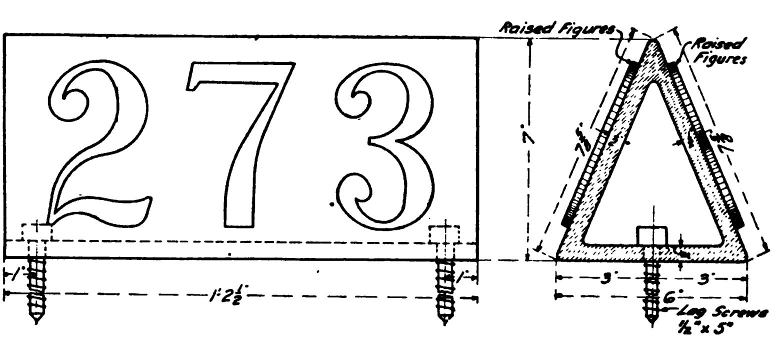
The mileage system, however, like all good things, is not without its faults. One difficulty is the lack of permanency in the location and marking of mile posts. If the location of the mile post is changed, it necessitates a change in bridge numbers and leads to confusion in the records. Mile posts once established should be permanently and substantially marked and thereafter regarded as permanent reference points not to be changed, except for very good reasons, long intervals of time, say a generation or two.

Another difficulty is the hair splitter, who is constantly finding slight changes to make in mileage numbers to get them just right. It has been customary in giving numbers to use the mileage of the "near" end of the bridge. It would be better to use the mileage of the center of the crossing, such as the center of the channel of the stream, the center of the street, or the center of the railway crossing; this, because the approaches to a bridge are often of a temporary nature and liable to be filled or shortened; or, a long trestle may be filled, leaving several openings which require individual numbers. In the latter case, the main bridge would retain the original number. Mileage numbers should be carried through main lines from end to end. On branches, the mileage should begin at point of junction with the main line. On short branches and spurs the bridges can be given the junction mileage, with sub-letters, as "79.4A;" "79.4B," etc. At junctions the initial point for branch line mileage should be the head block of the junction switch. The junction station is frequently located in the crotch, and if the station is the initial point it may result in minus mileage for structures between the switch and the station.

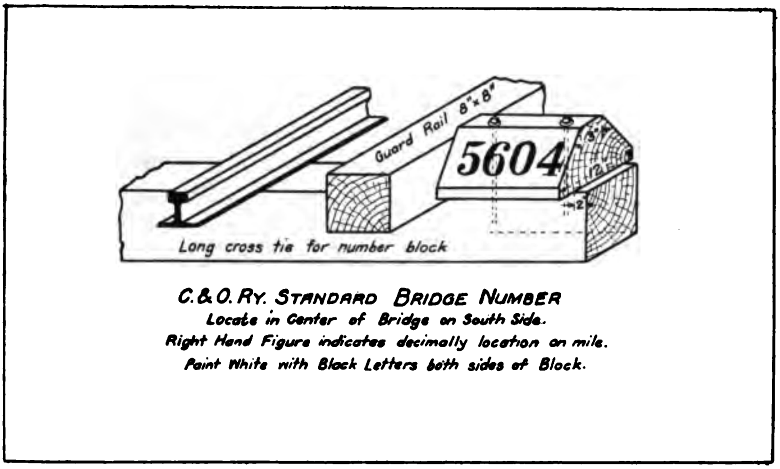
I. F. Stern,
R. H. Reid,
E. B. Ashby,
Wm. Graham,
Committee.



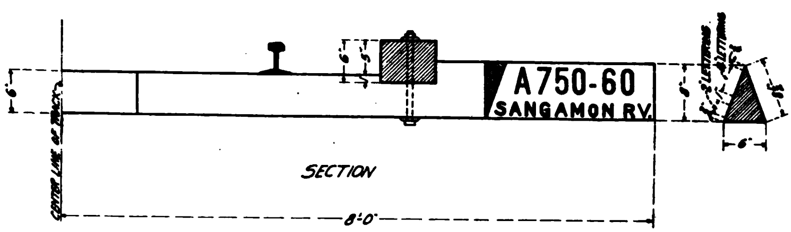
Southern Ry., Standard Bridge Number Board.



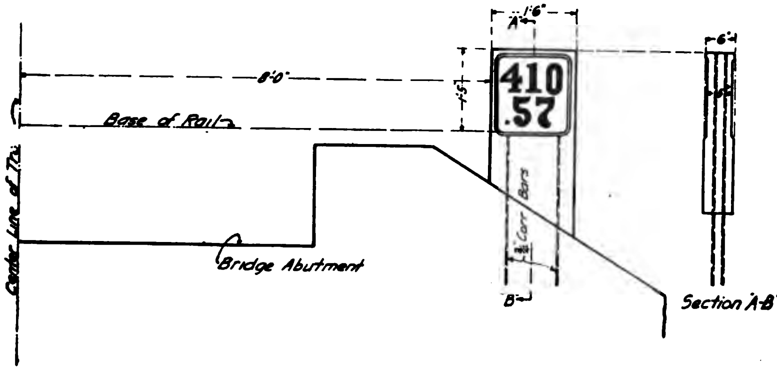
Louisville & Nashville R. R., Standard Number Casting.



Chesapeake & Ohio Ry., Standard Bridge Number.



Illinois Central R. R., Standard Bridge Numbering.



DISCUSSION.

Mr. Moore, New York, New Haven & Hartford R. R.:—Within a few years we changed over from the consecutive system to mileage numbering, believing it to be a great advantage in locating the structures. In compiling our new books we used two parallel columns, one giving the old number of the bridge, and the other its new number. The stations are also numbered on the mileage system, so that we immediately know how far the bridge is from the nearest station. We place a zero point arbitrarily at the beginning of each branch and number from there to the end of the branch. There was a good deal of argument against this method of renumbering when first the matter was brought up. Those who opposed it contended that it would make endless confusion; that our people, having been accustomed so long to the old way of numbering, would not readily locate the bridges by the new system, but we found that was not so. Within six months everybody was well pleased with the change. No confusion arose at all. Having tried the milage system for about four years we would not think of changing to any other plan that we know of.

The President:—Will you please state how you manage the numbering of branches nearly parallel with the main line? How do you distinguish the milage numbering on one branch from that of another?

Mr. Moore:—Each branch is given a name.

Mr. Staten:—We have used the mileage system for numbering bridges on the Chesapeake & Ohio for twenty-two years. It is as easy to number them on the branches as anywhere, for the branches are provided with mile posts, and each branch is designated by a name. If a bridge is filled we discard the number block or repaint it and use it elsewhere; if a bridge is added we designate it by the mile and tenth corresponding to its location. We have about twenty different branches, but we find no difficulty in locating any bridge on any one of them.

Mr. Swartz:—We have a system of numbering our bridges and culverts on the Grand Trunk Ry., which we think is pretty hard to beat. Our system is divided up into divisions and the divisions are subdivided into districts. The bridges are numbered according to the mileage system. I brought one of our books with me and will pass it around if any one cares to look at it.

Mr. Andrews:—I want to say that, personally, until the last year or so, I have always been in favor of the mileage system of numbering. During the past year or so we have made a number of changes in our line, that is, in some places shortened it, and in many places cut out existing structures, and it has unquestionably caused confusion in the original numbering. Originally our road was numbered consecutively, in sections to the Ohio river, beginning in the year 1828 and completed in the year 1857. You see it took several generations to decide on the numbers to be placed on the bridges. I want to say here that I was not one of the original generation. However, that part of the road is today numbered consecutively on the main line and on the branches which now form part of the main line. On other parts of our road bridges are numbered by the mileage system. For example, let us consider the line from Baltimore to Philadelphia: Since that was built the mileage has been changed. The original terminal was cut out and the belt line put in, which increased the mileage at that point about four miles; so the original numbers, while based on the mileage system do not now correspond to the revised mileage. They were numbered in this way; the first bridge we will say was in the tenth mile, that bridge was known as 10-A. If there was another bridge in that mile, it was known as 10-B and so on, until we got beyond the mile; then we commenced with 11-A.

But since that time, the method that has found the most favor with our people is to take each division separately, starting with No. 1 on the main line and continuing through with consecutive numbers to the terminal point of the main line of that division. The first branch would be in the two hundreds; the second branch would be in the three hundreds; and so on up.

Every bridge that we have over a 6 ft. span is charted and placed in a folio with the bridge number, the name of the stream, the nearest station east of the bridge, and the telegraph pole at or nearest the bridge, every fifth telegraph pole being numbered by the mileage system. By doing that we find that we get better results, with less confusion, and we can tell from our chart the exact location of the structure.

We have another line which was acquired by our company in late years that is numbered by a mileage system that is rather confusing to everybody except those who are familiar with the division, and that is in this way: We will say that bridge 1728 means a bridge in the 172nd mile. By that system with bridges that have four numbers, the first three numbers will be the full mileage and

the fourth number will be the decimal part of the mile at which the bridge is located. With bridges having three numbers, the first two figures will be the full mileage and the third figure will be the tenth, so that bridge No. 128 will be eight tenths of a mile beyond mile post 12. That is a very good system, because new bridges put in between two others need only to have the fraction of the mile added to them.

But I have to say that even though I have always been in favor of the mileage system, the one that now finds most favor with our company is in numbering by the hundreds; that is, the main line commences with one and goes up to one hundred; and if we run over one hundred, the first branch would have to be in the three hundreds; and in that case we begin with three hundred. But where we have less than one hundred bridges on the main line the first branch starts with two hundred and we always know immediately on what branch a bridge is located.

Mr. Schall:—On the Lehigh Valley R. R., bridges are numbered according to the location in miles from New York. For the branch lines a letter denoting the branch line is prefixed to the number. On the main line bridges are numbered according to the mile in which they are located; for instance, with bridges between mile posts 12 and 13, the first bridge receives the number 12, the second 12A, the third 12B, etc. For branch lines the same system is followed except that a letter is prefixed to the number; for instance, on the Perth Amboy branch, bridges are numbered according to the distance from New York; thus bridges between mile posts 20 and 21 would receive the numbers P. 20, P. 20A, P. 20B, etc. For openings of less than 5 ft. box culverts and pipes the same system of numbering is used, except that a cipher is placed in front of the number.

I find that this system of numbering is not entirely satisfactory as it does not provide for the introduction of other bridges without changing the letters designating other bridges in the same mile.

The decimal mileage system of numbering is very elastic and provides for adding other bridges. The bridges would be numbered 12, 12.12, 12.18, 12.45, etc. By using hundredths it will allow bridges to be placed within about 53 feet, whereas if only tenths were used the interval would be about 530 feet. The latter space is too large and some interference in the numbering system on that basis would have to be expected. When a bridge is taken out and abandoned we leave the number vacant. If a bridge is added it would be say 12A½ or 12A¾, etc., as the case may be. I am strongly in

favor of the numbering of bridges according to miles and fractions of a mile expressed in hundredths.

Mr. Killam:—The matter pertaining to bridge numbering is something that I have given considerable attention. When I came to the Intercolonial Railway, in 1887, I was instructed to go out and inspect the bridges and buildings on the line. I went out over the road the first year with a young engineer. We made a record of all bridge structures, but when we compared our notes with the records in the office we found the latter incomplete. We compiled a new set of books giving details concerning each structure, which is explained in the committee report. It will be useless, therefore to repeat it here.

Mr. Pickering:—I am looking for a Moses to lead me out of the wilderness but he has not yet appeared. The numbering of bridges is a vital question with me. I have a territory between Boston and Portland that has two main lines practically parallel. They were originally two separate divisions and the bridges were numbered consecutively on each. I may get a telegraphic report, we will say, for instance, that overhead bridge No. 95 has a broken plank. How am I to know which one of these lines it is on? There is a bridge numbered 95 on the Dover route, also one of the same number on the Portsmouth route; then, to make it more complex, there are about forty branches from the two main lines and one at least of those branches is between the two lines. The other branches interlace, so that they run in all directions. I wish to learn of a system of numbering which is simple and yet so practical that, when a telegraphic report is received concerning any bridge on the division requiring attention, it can be readily and accurately located. I consider that it would not be practical with the mileage system, and I am certain that we do not get the desired result by the use of consecutive numbering. The latter system is objectionable when it comes to adding new bridges, while that is not the case concerning the former. With the consecutive system, additional bridges would require a letter or fractional suffix, and these are objectionable for the reason that the suffix is liable to be omitted in a telegraphic report.

Mr. Andrews:—If Mr. Pickering has two main lines so far apart that they can not be classed as double-track he can certainly take one of the lines and begin with No. 1. Suppose, for instance, that that line would have 275 bridges. Then begin the other line with No. 301. That line ended with No. 475, then begin on the first branch with 501, and so on. In that way there will be no con-

fusion because no two branches on the division will be numbered alike.

Mr. Smith (Mo. Pac. Ry.) :—Anyone here connected with a railroad system that extends over a large territory, such as the Missouri Pacific and the Iron Mountain, is up against it for a numbering system, as Mr. Pickering suggests. The most satisfactory system I have found is that given to the bridges on the St. Louis, Iron Mountain and Southern Ry. When that system was not so large as at present the bridges were numbered from 1 to 778 at Texarkana. Then they started in at a branch point the next number above ten. For example the last bridge on the main line to Texarkana was No. 778; then the first bridge on the first branch line would be No. 781. If we get telegraphic report of trouble at bridge No. 1062, we know it is on the Cairo branch. I give you that as an example. It is feasible to take any division of our system, of which we have eighteen, and on none of them would we need have more than three figures. We need not go higher than 999 on any one division, although we have 10,000 bridges on the system.

The only drawback to this method is the fact that if a bridge is eliminated, the consecutive numbering breaks; if bridges are added, letters must be given them. If two or three bridges are added between bridges No. 620 and No. 621 they could be designated as 620A, 620B, etc. Again, suppose a bridge was to be added between 620A and 620B, I do not see any objection to renumbering them in such a way as to make the alphabetical suffixes come in regular order, to avoid the use of fractions.

We have a place in Louisiana on our lines where there are twenty bridges in one section, and the letter suffixes run up to T. They are all bridges and are numbered from 72-A to 72-T. It is in a rice country, where there are many flumes under the track. As those bridges were put in the letters were changed as described above. It does not follow that they were constructed in the order of A, B, C, etc., as numbered, but we changed the letters in the way I have stated. I do not see how the mileage or decimal system is going to overcome this objection—two objections, in fact—first, littering up telegrams with the name of a station in every case, and in some instances it will be necessary to say east or west or north or south of a station. Near a junction from which several lines radiate there may be the same, or nearly the same mileage numbers in several directions. Again, we might have a bridge at a mile post 1912 and another one at 191.20. The telegraph operator will frequently leave out the decimal point and he will invariably leave off

the cipher in which case they would appear the same. The only way to be certain when using that system would be to refer to the nearest station. If the bridges on any one division are numbered consecutively it is simply necessary to state the number of any bridge, when it can be readily located.

Mr. Andrews:—I do not believe that the principle which I submitted is understood yet. The gentleman seems to think we have to number the entire system consecutively. I did not intend to convey that impression at all. I think I stated clearly that we number each division separately, beginning on each division with No. 1.

Mr. Jutton:—Mr. Smith has stated that in the consecutive numbering system when a new opening is made and a bridge put in, as, for instance, between numbers 72 and 73, the new bridge should be numbered 72-A, and if more bridges are inserted between bridges 72 and 73 other letters could be used. I believe that trouble would ensue in such a case if a bridge were inserted between Nos. 72 and 72-A. It would be rather difficult to assign a number to such a bridge without confusion unless 72-A were changed.

I think fractions are better than letters, under such conditions, as their sub-division is practically unlimited, i. e., a fraction can always be inserted between two other frcations. On one line of road which I have in mind when construction was completed only the open bridges were given numbers; none of the culverts was numbered. It was afterwards decided to number the culverts by the use of fractions, and we now find fractions in use with the denominators as large as 21sts. If letters had been used in numbering these culverts I think a great deal of trouble and confusion would have been encountered. Of course, where letters and fractions are used in connection with the whole numbers there is the danger that in writing letters or sending telegrams about such bridges the suffixes might be left off, but this is a difficulty that we would have to contend with.

Mr. Smith suggested that if a new bridge were inserted between bridges 72 and 72-A the new bridge could be given number 72-A and the other bridge could be numbered 72-B, but it is a serious thing to change the number of a bridge, especially if the bridge has had a number for a long time. The correspondence and all the records concerning that bridge would have to be changed, and it would be very easy to overlook something in doing that.

One of the points urged in favor of the mileage system is that a bridge is located by its number, but I question the value of this feature. If, with this system of numbering, a bridge was reported

a comparatively few local men could readily give its location, but I doubt if many of the operating officials and general officers would stop to figure out the location of the bridge from its number corresponding to the mileage. They would go to the bridge record in their office to determine the location just as they would do with the consecutive numbering system. Then again, the men who would know the location of the bridge according to its number under the mileage system would probably have the same knowledge of the bridge under the consecutive numbering system, because they are men who are familiar with the location of the bridges, and when given the bridge number would know the location of the bridge no matter which system of numbering is used; hence I do not see that this point is a very strong one in favor of the mileage system. It seems to me that a great fault of the mileage system is the large numbers especially where there are so many branches, each of which would have to be indicated by a distinctive letter or name.

Mr. Shedd:—I would like to add a few words to Mr. Jutton's remarks in advocating the use of fractions instead of letters. I believe that fractions should be used when new openings are established in the main line and letters used for spur tracks; i. e., if a spur is constructed between bridges 72 and 73, say two miles long, the bridges and culverts on that spur should be numbered 72-A, 72-B, etc. In this way a bridge number having a letter suffix will indicate that the bridge is on a spur track. This would not apply to the more important branch lines, for which a system of numbering was suggested by Mr. Andrews.

Mr. J. H. Markley:—On our line each station is given a prefix letter corresponding to the division of the main line or the branch on which it is located. Our bridges are numbered in the same manner. I do not see how confusion can arise from that method.

Mr. McNab:—The Pere Marquette road adopted the mileage system over twenty years ago and we have never had any confusion resulting from it. The main line extends from Chicago to Petoskey, and on that we have the straight mileage system. The stations also are designated by the mileage system in the same book. Bridges on branch lines are given a letter prefix. Examples are: A13.4, B57.8, D76.4, etc. Every foreman has a small blue print book that he carries in his pocket, showing the location of all bridges in his territory. The dispatcher in the office also has a book of the same kind, so that if any one reports a bridge it can be located at once. We had a resurvey made and station stakes set every 500 feet. Every stake is numbered according to its station, which makes it

a very easy matter to locate bridges and other structures. We have also a small blue print book which gives the station numbers and shows the culverts, their size and kind so that when anything occurs it is very easy to refer to that book, and in a moment one can tell all about it.

Mr. Pickering:—I know of a case in point in regard to Mr. Jutton's suggestion of the use of fractions to designate bridges. In the City of Lynn, we have, or will have, when the elevation is completed something like eight bridges between numbers 13 and 14, and No. 14 has been abandoned; hence you can see that it is going to be very confusing, because on the other main line we have Nos. 13-A, 13-B, and 13-C at the present time.

The system that I had suggested was the decimal mileage system, starting with one main line at 100 and the other main line at 200, and each branch starting from the Boston terminal with A, B and C, prefixing the letter before the number. As yet I have not heard of anything here today that pleases me any better than that. I do not like the consecutive numbering system because it is confusing to add new numbers.

It is a serious thing to change numbers on our bridges, and it is also very confusing if we have several bridges bearing numbers that differ only by a letter or fractional suffix; we are likely to experience trouble in telegraphic reports, for they will occasionally be omitted.

Mr. Smith:—The system recommended by Mr. Pickering would not do on our roads. We have on our line no mile posts except telegraph poles. The nearest telegraph pole to any mile is painted white for about ten feet of its length and the mile number is painted on that. Every fifth pole is painted white for a short vertical distance and on the pole is painted the mile number in a horizontal line and below that the number of the pole, and by that means the bridges are located. The distance between poles then becomes the unit of measurement. Our bridges have come to be known by the pole reference. Enginemen going over the road wishing to refer to a bridge, catch the nearest mile post and then add the number of poles to the place where the bridge is located.

If the bridges were numbered by a separate system of mileage from that used by the telegraph poles on the line, it would be confusing. On the other hand it is not possible for us to follow out any definite system of numbering on our road, because our system is not numbered consistently with those mile posts. There are some through lines that have now become main lines of traffic that were

originally composed of four or five different companies. The mile posts on those lines, for counting purposes, start at zero, where construction commenced, and run up to the highest number. In some cases we have four or five sets of mile posts on such lines.

Mr. Aldrich:—As Mr. Moore has said, our road has the mileage system of numbering. When we first began to use it I thought it a pretty poor system, but the more I use it the better I like it. Every man knows his own territory. If we get a message that a train reports a certain bridge as being out of order, we simply refer to a time card to locate it. If we are in doubt as to which particular branch it is on the number of the train reporting it will assist in locating it. If one has a time card he virtually has a list of the bridges. I think it is a very simple matter. There are some sixteen branches on the territory that I cover, and I never yet have had a report of a bridge that I could not locate by putting my hand in my pocket and taking out a time card. I think that mileage numbering is the best system that has been suggested for our lines. We have some bridges that have been added to about the same territory that Mr. Pickering spoke of, on what we call the Harrison elimination. It is very easy to number those bridges by the mileage system.

Mr. A. S. Markley:—We have used the mileage system as well as that of numbering by telegraph poles. We have concrete posts for our mile posts. We then numbered every fifth telegraph pole, but the number of telegraph poles per mile has been changed from thirty to forty-two, generally while in some places we have thirty-five. If the poles were all set at like distances they would lend themselves to the simplest method of locating bridges that I know of.

Mr. Killam:—Mr. Pickering speaks of the difficulty of locating the bridges on two parallel lines. Certainly those two parallel lines do not bear the same name. Then, if there is any difficulty, it would be for the want of proper information being given. It should not be difficult to locate from the telegraphic report which line the bridge in question is on.

In reference to the mile posts; originally with our road, some thirty years ago, the mileage was numbered on square blocks on telegraph poles, but in taking them down year after year, when it became necessary to repaint the numbers they would sometimes get up in the wrong place and the telegraph company would come along and take their poles down and put in a new one and finally the number board would get lost. We measured the entire road and

put down cedar posts with the blank side from the road, and on one side was given the mileage from Montreal and on the other side the mileage from Halifax. The branches were also furnished with mile posts of a similar kind.

The Chairman:—Does your system of bridge numbering refer to the mile posts?

Mr. Killam:—The mile posts are shown in the bridge books, and they are of considerable service in locating the bridges. We can always tell by referring to our books between what two mile posts any bridge is located.

The President:—The committee, in its summary, states as follows: "We do not believe that the association, as an association, wants to introduce any particular system nor to go on record as advocating that particular system; but we believe that a compilation of the answers received makes a valuable addition to the literature of bridge numbering, and that we, as an association, ought to be content with that." It seems to me from the discussion that has been had so far, we cannot come to any definite conclusion, and it occurs to me that it would be useless to discuss the matter any further. I think that we should adopt the report of the committee as it stands, without making any specific recommendation. I would like to have the opinion of the members.

Mr. Pickering:—I move that we adopt the report as it stands.

The motion was seconded and carried.

J. H. Markley, Pres. 1906-7. **L. D. Hadwen,** 3rd V. Pres. **G. W. Andrews,** Pres. 1894-5. **J. N. Penwell,** 2nd V. Pres. **Jas. Stannard,** Pres. 1896-7. **A. E. Killam,** 1st V. Pres. **B. F. Pickering,** Pres. 1902-3. **F. E. Schall,** Pres. 1911-12. **A. S. Markley,** Pres. 1899-00.

Subject No. 4.

BUILDINGS AND PLATFORMS FOR SMALL TOWNS.

(Continued from last year.)

REPORT OF COMMITTEE.

Relative to the "Arrangement of Buildings and Platforms for Small Towns as to Convenience and Appearance" reported at the last meeting which was referred back to the committee:

The criticism of the report seems to have been in regard to the track back of the depot, and the elevated platform.

As for the track back of the depot, the thought seemed to have been lost sight of that the report distinctly stated: "For stations where but a small amount of freight is handled, a house track back of the station is not desirable. Where, however, a large amount of freight is received, as is occasionally the case in small towns and on busy roads, and where considerable time would be lost by local freight trains getting out of the way of other trains, a track back of the station is desirable." It was not intended to make this a general standard, but to be used in cases where considerable quantities of freight being received could be unloaded while waiting for other trains to pass. If such conditions do not exist, the committee does not recommend the layout.

Concerning the platforms, general conditions must govern. If heavy freight is received, a high platform of proper size is usually desirable.

At some small stations, large quantities of cotton, broom corn, oil in barrels, ore, etc., are received for local shipment. In such cases an elevated platform would seem a necessity. They should be placed as conditions would seem best for transferring from wagons to cars or vice versa, and far enough from other buildings so as not to endanger them in case of fire.

For the above reasons and with these explanations, the committee does not see its way clear to change its last year's recommendations, and begs to submit the following conclusions:

(1) Passenger stations and combination passenger and freight stations with their platforms should be contiguous to and face the main track.

(2) Where but a small amount of freight is handled, platforms level with the car floor are not generally desirable. Where a considerable quantity of heavy freight is handled, platforms at or nearly the height of the car floor are desirable. Such platforms may be adjoining the station building or at a distance from it contiguous to a team or unloading track as conditions require. When they constitute a part of the depot platform, they should not in general extend nearer the main track than the front line of the station building and in no case nearer than eight feet of the main track rail.

(3) Grain elevators, oil houses, cotton, broom corn or other platforms or buildings storing inflammable or semi-inflammable merchandise should be located, as far as practicable, so as not to endanger railway or other property.

(4) Section tool houses should, where practicable, be located adjacent to the main track and preferably outside of side track limits.

C. H. Fake,
N. H. LaFountain,
H. M. Jack,
B. F. Beckman,
O. H. Andrews,
R. J. Bruce,
Committee.

DISCUSSION.

Mr. Fake:—I would like to state to the convention that I was unable to be at the meeting in Denver last year, and there was some discussion on a portion of this report. I called the attention of the other members of the committee to the report, stating that this particular paragraph was only an exception, and when they understood it in that way it was agreed to by all. I also wrote to the different members of the association who discussed the question, and when they understood the meaning of it, they agreed that it was practically satisfactory. The report of last year upon which there was discussion, under which it was returned to the committee, reads: "For stations where but a small amount of freight is handled," etc., (reading this portion of the report).

That is the paragraph on which the convention had the question resubmitted to the committee, and when it was understood that way it was not taken fully into consideration, I judge from the discussion, but it stated that where but a small amount of freight is handled, a house track back of the station is not desirable. The committee fully agrees that a track back of the station is not desirable except in special cases, but in certain cases it is quite desirable. The convention seemed to think that the report was intended to convey the meaning that there should be a track back of the station in all cases, which was not the intent and meaning if the committee's report at all.

Mr. Penwell:—I was one of the members referred to in this discussion last year, and after having some correspondence with Mr. Fake during the year, and after reading his proposed supplemental report I wrote him to the effect that I was ready to recommend the report with the additional paragraph that he has just read. There is only one exception that I could now take to that, and that, as was mentioned in my letter to Mr. Fake, does not interfere with the adoption of the report. I am therefore ready to move the adoption of the report, but am not entirely clear as to whether or not the extra track makes it necessary to put in an extra switch in

the main track, particularly on double-track roads where a double-end siding would necessarily require a facing-point switch. If this track can be laid without putting in an extra switch in the main track I am ready to move the adoption of the report. I think it is a good one. Mr. Fake may have something in his mind on that point, and I would be glad to hear further from him.

Mr. Fake:—I have only to say that some switches are always necessary on a railroad. The committee realized the importance of having as few switches as possible in main track, particularly on double-track roads where a double-end track back of the station would have one switch facing. At the same time, there might be occasions where a facing-point switch would be desirable even in that case, as I stated in a letter that I read. I know of one instance or two where at least one to two hours' time was saved in train service by putting this track in behind the depot. Now whether that fact would be of sufficient importance to outweigh the objectionable features of such an arrangement I would say should be left to the superintendent of the road or to those who have the responsibility of the management. I fully agree that it is desirable to reduce the number of switches as much as possible, but we must have at least some, and, if necessary to save time, the only thing to do is to put in enough switches to accomplish that object.

Mr. Penwell:—With the understanding that I get from Mr. Fake's further explanation in regard to switches, I move the adoption of the report.

(Motion seconded.)

The President:—Is there any one else who desires to speak on that subject? I think it would be rather hasty to take action without further discussion.

Mr. Penwell:—It was not my idea to bar out any discussion.

The President:—It has been moved and seconded that the report of the committee be accepted, and the committee be discharged. (The motion was unanimously carried.)

SUBJECT No. 6.

BEST AND MOST ECONOMICAL PUMPING ENGINES.

REPORT OF COMMITTEE.

The committee has given this subject a considerable amount of study, and has conducted a number of tests and investigations in order to submit to the association as complete a report as possible written within the short space of time allotted for such work. The committee does not feel that it is in a position, based upon its investigations, to recommend the best and most economical pumping engines for general use, for the reason that a proper and complete report in this connection would mean a recommendation for each and every condition encountered in railway water service and it is well known that such conditions are very numerous.

Instead of making a report strictly in accordance with the subject in hand the committee was of the opinion that the report would be of greater value if it would make a number of tests with different types of pumping units and submit such tests to the members for their consideration. A tabulated report of such tests and investigations is presented herewith, which is short of several types of pumping units that are used by railways for the reason that the committee did not have access to plants which were properly equipped for carrying on the investigation that they desired, and where tests could be made that would be absolutely reliable and thus avoid only approximate conclusions.

The data submitted herewith, in the accompanying table, was gathered from water stations where reliable figures could be obtained as to the amount of fuel consumed and water pumped, resulting from actual weight and measurement of fuels, reading of meters, etc., and it is correct in so far as the locations and conditions of the various stations are concerned. The points selected where the tests were conducted were such as are commonly found in railway service, and the same results may be accomplished at any station where similar conditions exist.

All of these tests have been reduced to cost per water horse power per hour, and in each instance the cost of fuel is given which can be used as a basis for fuel at any other figures.

The committee would recommend this merely as a progress report and would suggest that such tests and investigations be continued.

C. E. THOMAS,
J. DUPREE,
G. H. JENNINGS,
R. A. LUKER,
J. B. WHITE,
Committee.

Comparison Statement of Tests.

	BOILER		PUMP		Total Head (Feet)	Water or Thermal Horse Power	Gallons Per Minute	FUEL		Cost Per Horse Power Hour
	Type	Horse Power	Type	Size				Kind	Price	
1	Vertical, ...	45	Duplex, ...	10x6x10	104	5.09	194	Mine Run Coal, ...	$2.00	$0.0316
2	Locomotive, ..	60	Duplex, ...	10x6x10	196	10.6	215	Mine Run Coal, ...	2.00	0.0306
3	Vertical, ...	45	Duplex, ...	14x8½x12	139	10.8	309	Mine Run Coal, ...	2.00	0.0354
4	Locomotive, ..	60	Comp. Duplex, ..	14x20x12x18	220	23	418	Screenings, ...	1.00	0.0097
5	Walled in, ..	150	Comp. Duplex, ..	14x20x12x18	220	24	438	Screenings, ...	1.00	0.0070
6	Walled in, ...	80	Duplex, ...	14x8½x10	37	3.8	404	Screenings, ...	1.00	0.0210
7	Motor, ...	25	D. A. Triplex, ...	8½x10	49	7.6	611	Electric Current, ...	.04	0.0420
8	Walled in, ...	40	Deep Well, ...	12x8x36	93	5.48	117	Screenings, ...	1.00	0.023
9	Vertical, ...	40	Deep Well, ...	12x8x36	51	1.6	125	Mine Run Coal, ...	2.00	0.0640
10	Gasoline, ...	12	Deep Well, ...	7½x30	108	3.4	124	Gasoline, ...	.12	0.0600
11	Vertical, ...	45	Air Compressor, .	12x12x12	230	16	276	Mine Run Coal, ...	2.00	0.0320
12	Gasoline, ...	6	Single, ...	6x18	61	2.05	133	Gasoline, ...	.12	0.0402
13	Gas Engine Oil Fixture, ..	6	Single, ...	8x10	59	2.54	171	Power Distillate, ...	.03¼	0.0094
14	Oil Engine, ...	12	S. A. Triplex, ...	8x8	143	9.1	252	Fuel Oil, ...	.02	0.0026
15	Gasoline, ...	6	Double Acting, ..	8x10	71	2.51	140	Gasoline, ...	.12	0.0486

DISCUSSION.

The President:—The assistant secretary will please read the report. You have all been supplied with copies of the printed report. Is Mr. C. E. Thomas in the hall?

(Report read.)

The President:—Mr. Thomas, will you please take charge of this discussion?

Mr. Thomas:—Mr. President, this report is not as complete as the committee desired to have it for this meeting. For that reason there are quite a few different pumping units that are not included in it. While we have information on some of them, there is not sufficient data to reduce them to cost per horse power hour. The committee would recommend therefore, that the report be continued another year, at which time we contemplate being able to furnish a report showing in detail the estimated cost per horse power for installation of the different types of pumping units, and along with that show the approximate maintenance cost per horse power per year, which, when made up on that basis, would give some very valuable information.

The President:—Gentlemen, you have heard the report and explanation given by the chairman. Is there any discussion? It hardly seems to me, from the explanation given by the committee, that discussion would be of great value as the report is one of progress.

Mr. Thomas:—In this connection, our investigation develops the fact that there are one or two railroads which have been changing internal combustion engines so as to use a distillate oil instead of gasoline. By so doing they are able to show a reduction in the cost of fuel of from 65 to 80 per cent. This distillate can be purchased for about three cents per gallon, whereas gasoline costs eleven to twelve cents. The same relative horse power is obtainable from the distillate as from gasoline.

The President:—Has any one else something to offer on the subject? The information is very valuable, but it is not complete. I would suggest that the committee be continued.

The Secretary:—I think it a good suggestion, because the committee will be able to gather considerable more information that will be of value. We should really take no other stand.

Mr. O'Neill:—I move that the report of the committee be accepted as a progress report and the subject be continued next year

(The motion was seconded and carried.)

Subject No. 8.

CONCRETE TANKS, STANDPIPES AND RESERVOIRS.

REPORT OF COMMITTEE.

Water tanks for railway service are usually constructed of wooden staves, with steel or iron hoops. The average life of a wooden tank may be taken as about 18 or 20 years, depending on kind of lumber used, care used in construction, and in the attention given to it, such as keeping it filled with water, not allowing water to freeze, keeping the outside painted, etc. The hoops also need constant attention, and in many cases have to be changed once or twice during the lifetime of the wood. Hoops are subject to corrosion, and as this fact was not always apparent without taking them off, it sometimes acted more rapidly than was considered possible, with the result that the hoops broke and the tank collapsed.

On account of these difficulties, other materials have been given consideration. Many steel tanks have been built and are the standard of some railroads, such as the Lehigh Valley R. R. Steel tanks require frequent painting, to keep them in good condition. This style of construction is most frequently used for the larger capacity tanks and reservoirs, say 100,000 gallons or over.

When a water station is established for temporary service, or when it is thought that operating requirements may change, a wooden tank is preferable, because it is easily taken down and reërected in a new location. For permanently located water stations, however, engineers have been looking for some more permanent form of construction, one in which the cost of maintenance is reduced to a minimum, and the introduction of reinforced concrete into all branches of industry has naturally turned their attention to its application to railway water tanks.

It is not generally known that the principles of reinforced concrete construction originated in the construction of tanks or water receptacles. A gardener in Paris, named Monier, desiring some flower pots larger than those obtainable in the market, conceived the idea of taking a wire mesh fabric, shaping it into the desired receptacle and plastering it with cement mortar inside and out. His plan proved successful and he then made some water barrels in the same manner. Later he built some larger reservoirs or tanks. The idea grew, was applied to one thing after another, until reinforced concrete has practically revolutionized construction methods.

While this report is intended primarily to give the present status of the use of reinforced concrete for railway water tanks, tanks and reservoirs built for the water supply of cities and for fire protection will be mentioned because the same principles apply. The earliest record of this form of construction in the United States is a standpipe built at Little Falls, N. J., in 1899. In a paper read before the Boston Society of Civil Engineers last June the statement is made that up to the time of writing that paper only 53 such structures had been built in this country and abroad, but the number is rapidly increasing.

There are many arguments to be made in favor of reinforced concrete water tanks.

(*a*) The required materials can easily be obtained in almost any locality.

(*b*) The experience gained with each tank built gradually decreases the construction cost.

(*c*) A concrete tank need not necessarily be kept filled with water in order to preserve it. Wooden and steel tanks rapidly go to pieces by being alternately wet and dry.

(*d*) It is easily kept clean, because no matter what kind of water it holds, nothing is absorbed by the concrete.

(*e*) There are no maintenance charges. Wooden and steel tanks require painting, calking, renewal of hoops, etc.

FOUNDATION.

It goes without saying that the foundation must be carefully planned and made, but that is equally true of wooden and steel tanks, and also of all railway structures. The foundation required will depend entirely upon the location, and must be determined for each individual case. In some instances it is found that concrete footings with comparatively little excavating are sufficient; in others the concrete footings can be put on grillage; and then, again, it is found necessary to drive piles, either of wood or of concrete. The argument has been advanced that uneven settlement will do less harm to the superstructure of a properly designed reinforced concrete tank than to a wooden tank; still that is not an argument for putting in a poor and insufficient foundation.

SUPERSTRUCTURE.

The design of the superstructure varies considerably, and to some extent is governed by the use to which the tank is to be put.

In a general way there are three designs—

(*a*) A cylinder or prism resting on concrete footings and used for its entire height as a water reservoir.

(*b*) A cylinder or prism resting on concrete footings, having a diaphragm or partition a considerable distance above the footings, that forms the bottom of the water reservoir.

(*c*) A tank of concrete resting on reinforced concrete posts, similar to a wooden or steel tank on a timber or steel husk frame or tower.

Design (a) is used where the volume or quantity of water is the main consideration or where the tank is located on an elevation.

Design (b) is used where the elevation is needed to obtain sufficient pressure, for hydrants or water columns, and where the hydrostatic pressure, if brought to the base of the tower, would be likely to cause seepage through the concrete. The lower portion of the tower can be provided with suitable openings and can be utilized for pumping machinery and for the storage of tools and materials. In case of trouble during severe winter weather, the pipes in a tank of this design can be thawed out without risk. You have all heard of tanks burning down because of trying to thaw out pipes on a cold, windy, winter's day.

The reason for design (c) is about the same as for design (b) without the frost-proofing feature. The various designs are illustrated in specific cases described later on.

ROOFS.

The roofing of concrete tanks and reservoirs is largely a matter of choice. Tanks and reservoirs for water supply located on an elevation, or where there is little soot and cinders, and little likelihood of dust or foreign matter being blown or thrown into them, can be left open, and they frequently are. In fact some railroads are building their wooden tanks without roofs.

A railroad tank should be provided with a roof, which may be of concrete, wood, tile, slate or prepared roofing, as may be desired. A concrete roof would be more in keeping with the structure and have the additional merit of permanency.

APPEARANCE.

The railroads of the country are giving more and more attention to the appearance of their buildings and grounds, especially at the larger and more important stations. Reinforced concrete lends itself very readily to artistic design, and this will be no small argument in favor of the concrete tank. Most concrete tanks so far built are straight cylindrical shafts without much attempt at ornamentation, yet even this presents at all times a better appearance than a wooden tank in need of paint. In Europe more attention has been given to ornamental design than in this country, and the addition of cut stone facing and trimming has added a great deal to the appearance.

There are many reasons why railroads have not taken up the construction of reinforced concrete tanks more generally. In the first place, up to the present time, because of the comparatively few structures of this kind that have been built, the work would be largely experimental, and most of us are inclined to let the other fellow spend his time and money on experiments.

Railroads that have severe cold weather to contend with would not care to try it until assured that the tanks would stand freezing weather without injury. The permanent location of many tanks on account of constantly changing operating conditions and requirements must necessarily be more or less uncertain.

Lack of experience in this form of construction will make the labor charge run high. Every reinforced concrete tank, standpipe or reservior built adds to the sum of knowledge and experience, and one is able to figure more confidently on satisfactory results.

In designing a concrete water tank the item that receives first consideration is the water pressure, because this determines the thickness of wall and amount of reinforcement needed, and makes precaution for waterproofing necessary. In a cylindrical reservoir the water pressure at the base, per square foot, is equal to the weight of one cubic foot of water multiplied by the depth in feet. Take for example a tank 30 ft. high. A cubic foot of water weighs 62.5 lbs. The water pressure per square foot at the base of the tank is $30 \times 62.5 = 1{,}875.0$ lbs.

The tension in the wall for each foot in height is obtained by multiplying the water pressure per square foot by the radius in feet. Take for example the above tank, which we will say is 20 ft. in diameter. The tension in the wall for the first foot in height is $1{,}875 \times 10 = 18{,}750$ lbs. Or it can also be arrived at as follows: $30 \times 62.5 \times 10 = 18{,}750$ lbs.

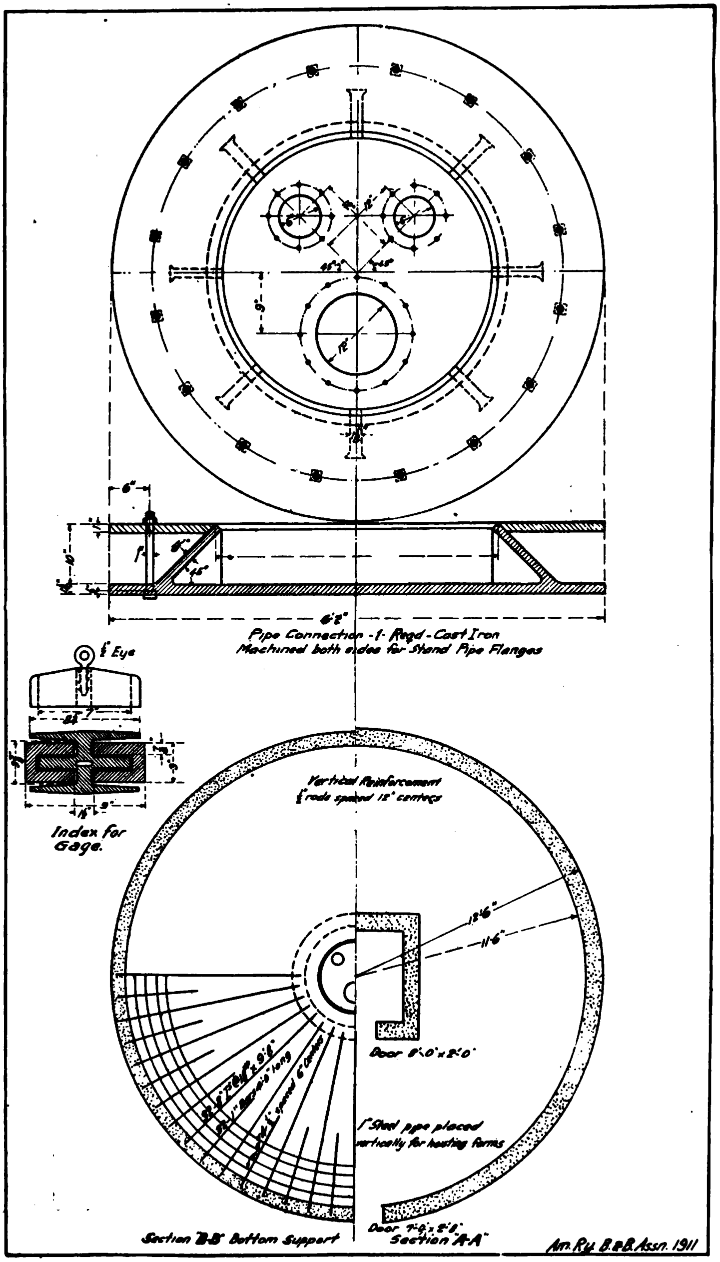
If the same tank were to be made 40 ft. high, the tension would be $40 \times 62.5 \times 10 = 25{,}000$ lbs., and if 50 ft. high, $50 \times 62.5 \times 10 = 31{,}250$ lbs.

It will thus be seen that increased depth of water materially increases the tension in the wall, and increased diameter also adds in proportion. Therefore, the larger the reservior, both as to diameter and height, the greater the need of an impermeable concrete.

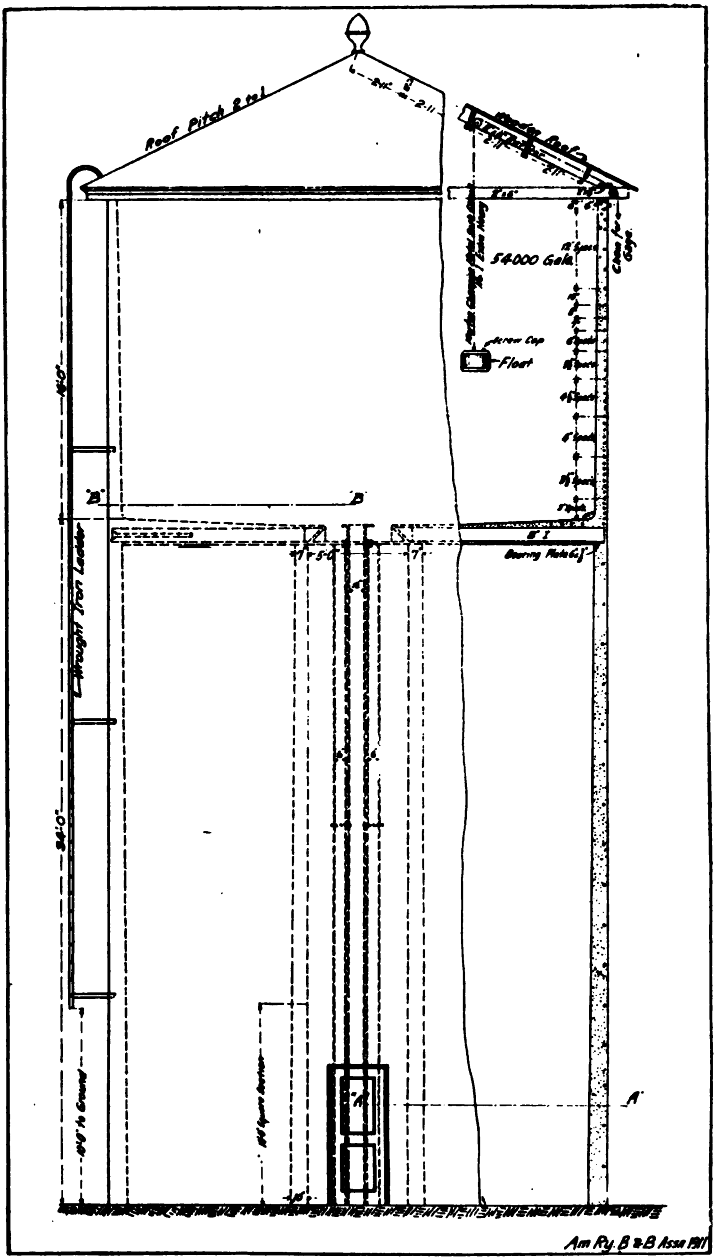
The Journal of the Association of Engineering Societies for June, 1911, has a paper by H. B. Andrews entitled "A New Theory for the Design of Reinforced Concrete Reservoirs," and a discussion by various engineers experienced in this line of work, that will be of value and interest to any one desiring to design and construct a reinforced concrete tank. This paper and also an editorial on it appear in the Engineering News of July 27, 1911. In the Proceedings of the American Railway Engineering Association, Vol. 12, part 3, 1911, will be found "Suggested Specifications for a Reinforced Concrete Water Tank" that are also of value.

Various means are used to insure a waterproof concrete, but it is usually aimed to accomplish this if possible by using a rich mixture, rather than by adding waterproofing compounds to the concrete or applying them to the surface. Hydrated lime or special preparations are sometimes added to the concrete for the purpose of making it denser and thus more impermeable to water. The walls and floor are sometimes coated with a 1:1 cement mortar

Concrete Tank, Austinburg, O.—Pennsylvania Lines.



Concrete Tank, Austinburg, O.—Pennsylvania Lines.



Concrete Tank, Austinburg, O.—Pennsylvania Lines.

or some waterproofing preparation of which there are a number on the market.

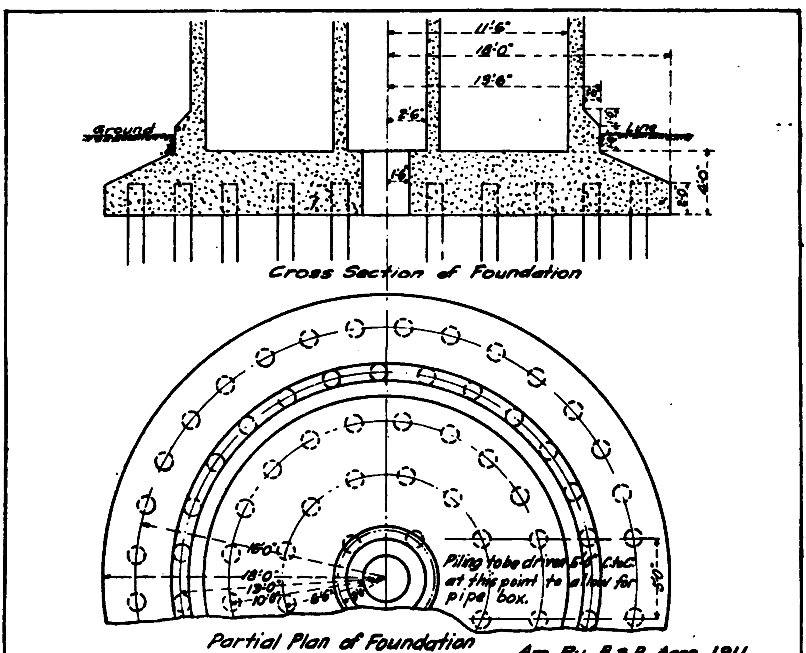
It is interesting to note that the standpipe on the state farm at Bridgewater, Mass., was built by inexperienced prison labor. The standpipe is 30 ft. in diameter, 78 ft. high, with walls 20 in. thick at the base and 12 in. at the top. The concrete consisted of cement, sand and gravel in proportions to 1 : 1½ : 3½ and was found to be absolutely water tight.

The steel reinforcement in the base should be carried up into the walls, because when the tank is filled with water the pressure tends to increase the diameter of the walls and might cause cracks at the juncture of the walls and base that would allow seepage. The sections of the horizontal reinforcing rods in the walls should be properly joined to make a complete circle.

At Attleboro, Mass., a standpipe 50 ft. in diameter was built and the following method was followed: Bars were obtained long enough so that three would reach entirely around the circumference with a lap of 40 diameters at each joint. Two wire rope clips were then used at each splice. These clips were tested at the Watertown arsenal and found sufficient to secure the full working stress of the bare bars.

The Pennsylvania Lines built a 54,000-gallon concrete water tank at Austinburg, Ohio, at a cost of $3,500. This tank is 24 ft. in diameter, 16 ft. deep, and is raised 32 ft. above the track level. The walls are 8 in. thick at the bottom and taper to 6 in. at the top. The drawings attached to this report show the details of construction.

A rich mixture of concrete was used with a set of watertight steel forms, and no other precaution was taken to make the work waterproof. It is felt by those having the work in hand that the success of this tank is due to the use of tight steel forms which retain in the concrete the fine particles of cement that might escape where wooden forms are used. Mr.



Foundation for Concrete Tank for Pennsylvania Lines.

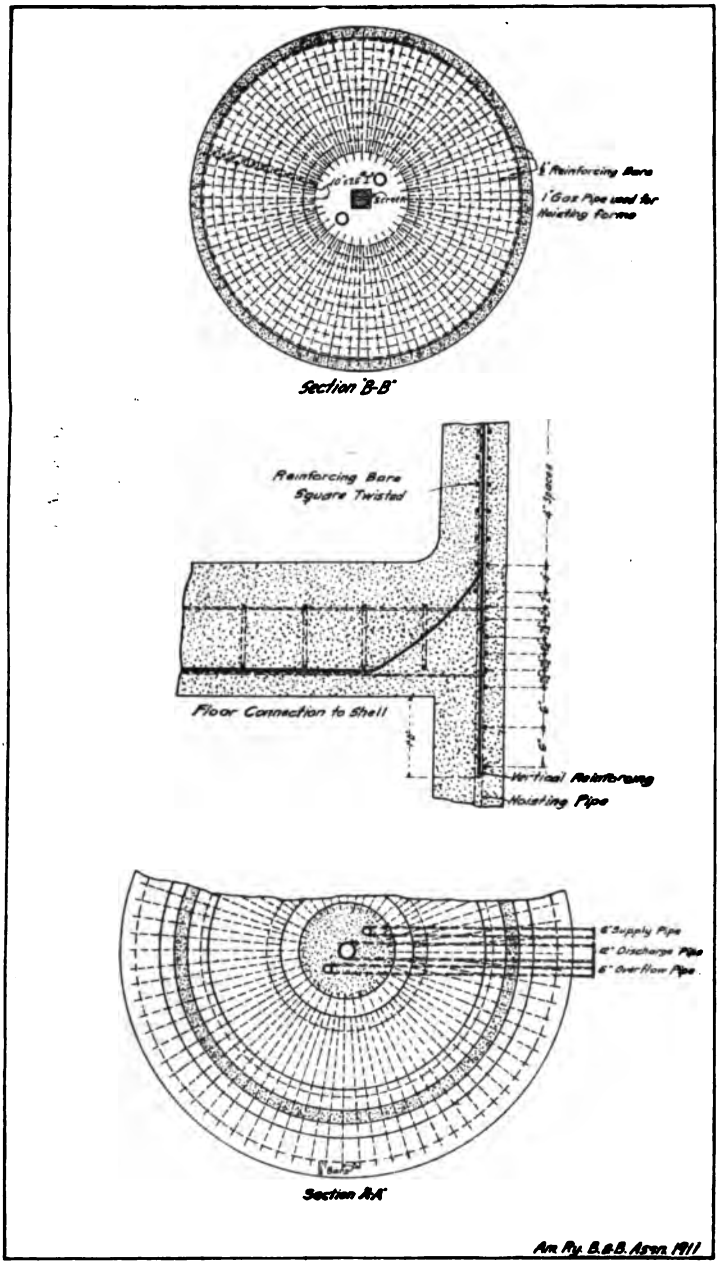
Concrete Tank, Austinburg, Ohio.—Pennsylvania Lines.

W. R. Hillary, division engineer, in charge of the work, states that from the experience gained he would not hesitate to construct another tank along the same lines; also that a tank of twice the storage capacity could be secured with very little increase in cost.

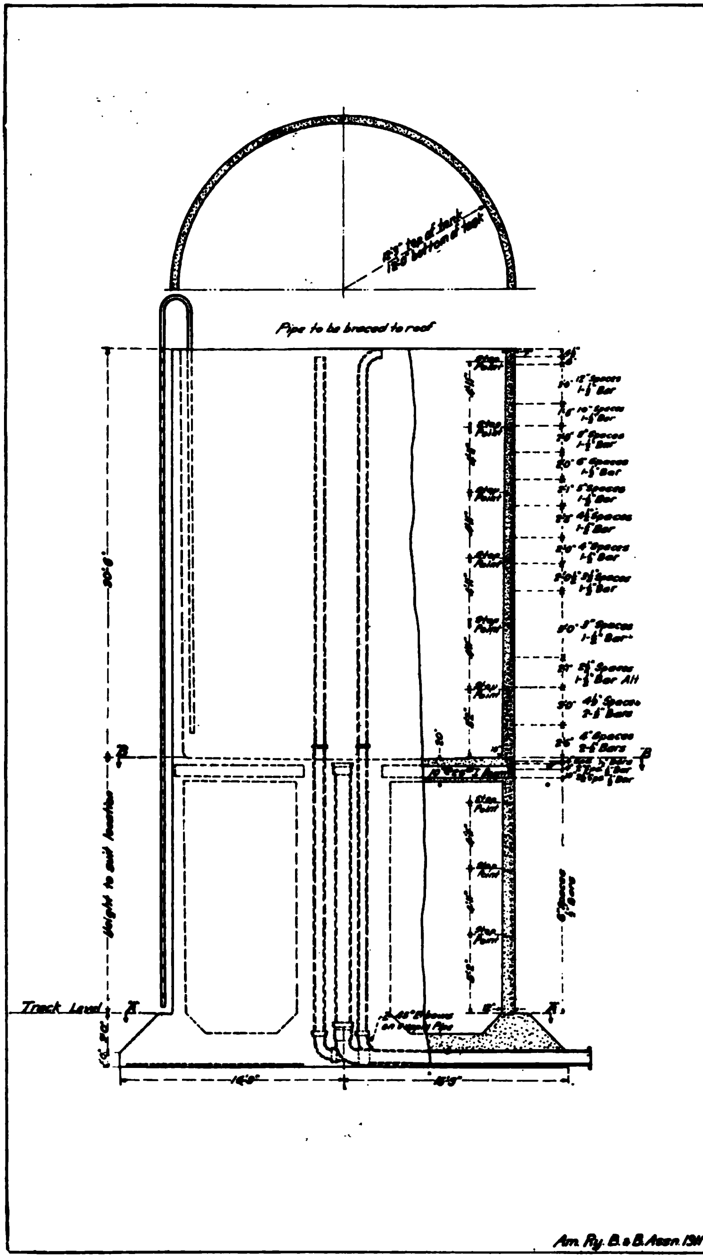
It was necessary to drive piling for this tank because a layer of quicksand was encountered in excavating. A wooden roof was placed on this tank, but Mr. Hillary states that if he were to build another he would use a reinforced concrete roof. The tank has given perfect satisfaction and has passed severe winter tests without showing any ill effects. The tank at Austinburg was built by the Steel Concrete Construction Company, of Harrisville, Pa.

The Southern Railway Company has built two concrete tanks, one at Ooltewah and the other at Bulls Gap. Drawings showing the latter are included in this report. These tanks were built of 1:2:4 concrete except in the tank proper, where the mixture was made richer, namely: 1:1½:2½, in order to insure water-tightness. No waterproofing compound was used. Both of these tanks showed a little seepage when they were first put in service, but this disappeared entirely after a month's service.

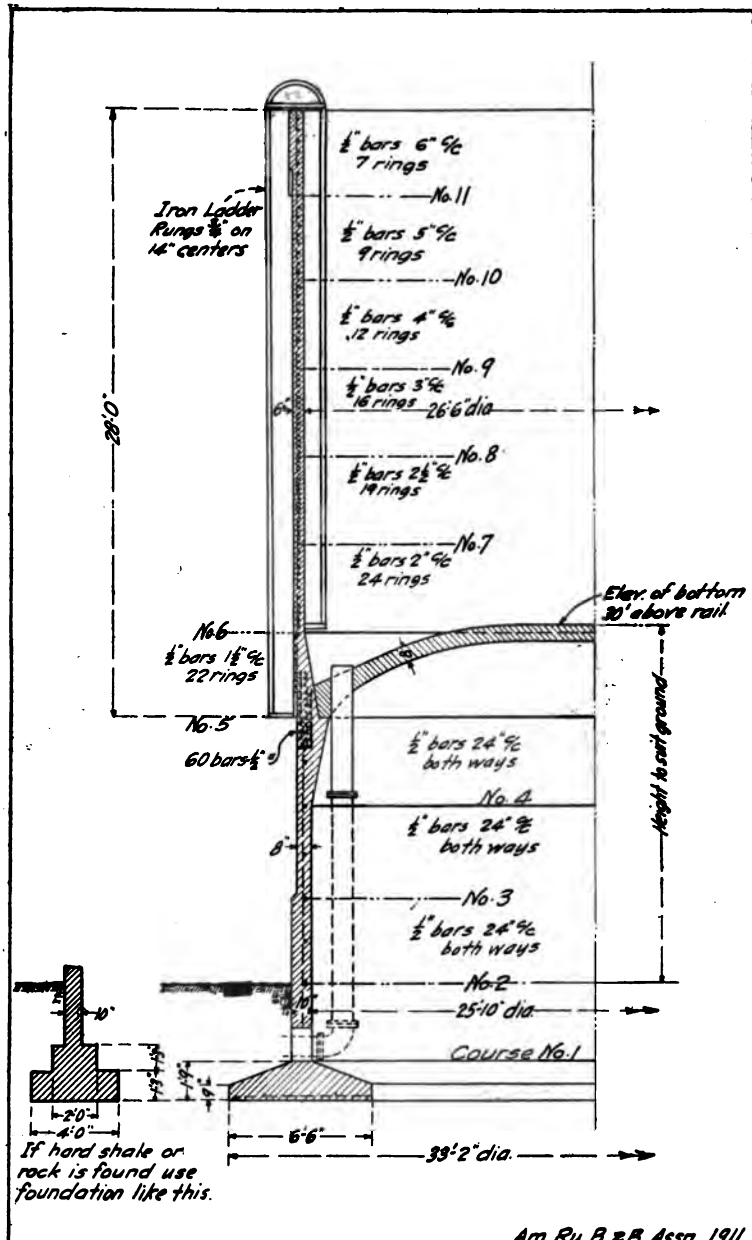
In 1909 the Southern Pacific Company, on one of its lines in Mexico, the Cananea, Yaqui River & Pacific Ry., built a reinforced concrete tank at Empalme, Sonora. A drawing showing the method of construction is attached.



Concrete Tank, 100,000 Gallons Capacity, Designed for B. & O. R. R., by the Steel Concrete Construction Co.



100,000 Gallon Concrete Tank Designed for B. & O. R., by the Steel Concrete Construction Co.

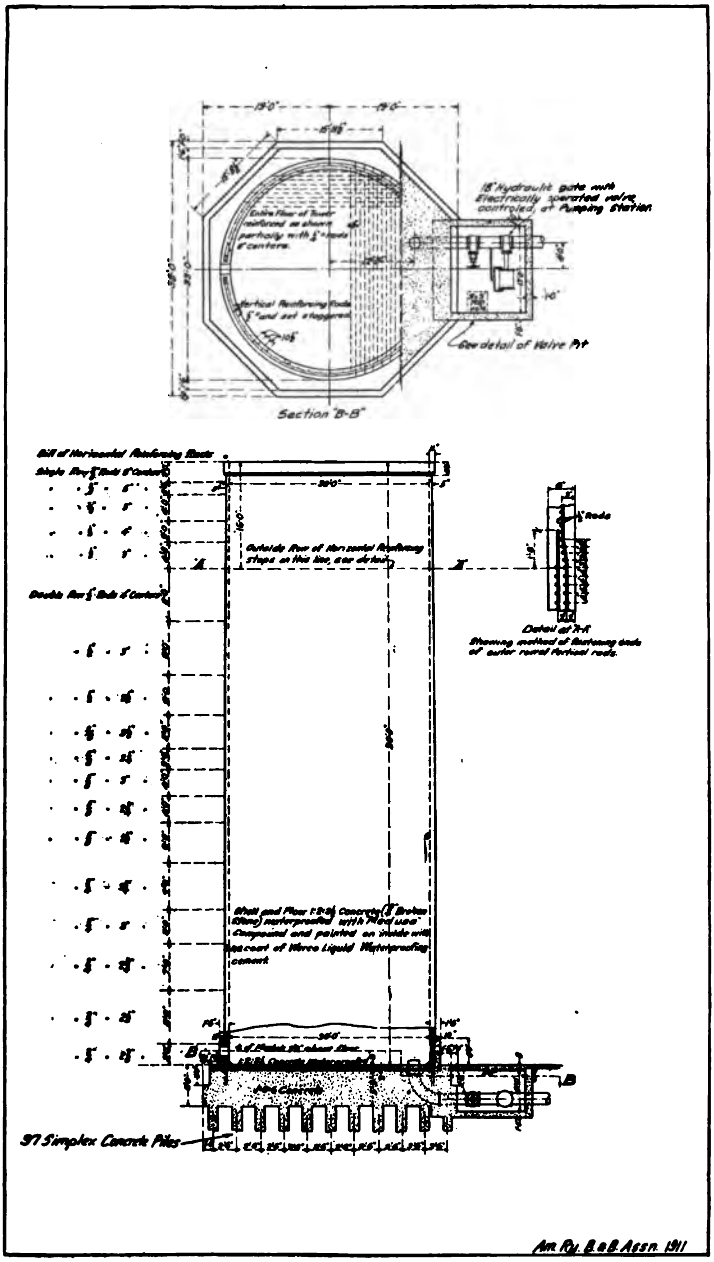


Concrete Tank at Bull's Gap, Tenn., Southern Ry.

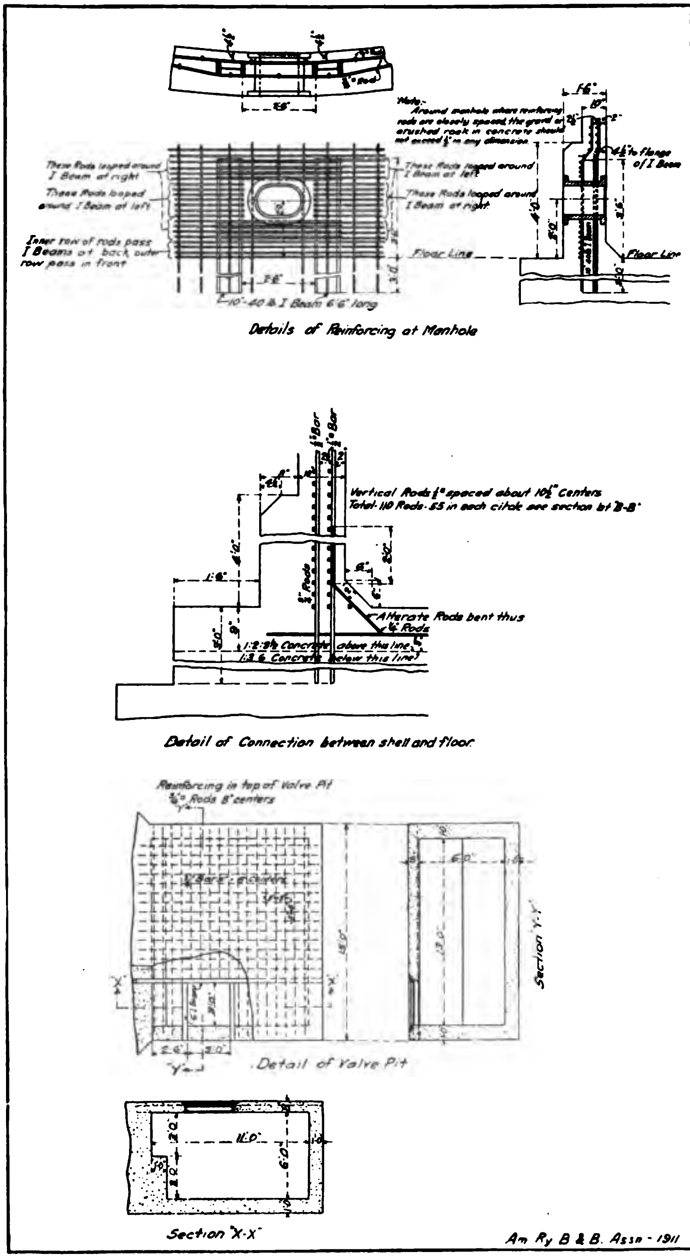
Concrete Tank at Ooltewah, Tenn., Southern Ry.

The foundation is octagonal in shape and rests on 97 Simplex concrete piles. Where the walls and floor join, the walls are 18 in. thick for a distance of 4 ft., and above that they are 10 in. thick at the bottom and taper to 5 in. at the top. The walls and floor are formed of 1:2:3½ concrete, with ¾ in. broken stone, and the foundation is of 1:3:6 concrete. The walls and floor are waterproofed with Medusa compound and the inside painted with one coat of Werco liquid waterproofing cement. When the tank was first filled it showed signs of sweating, but after a few weeks this passed away and the outside has been perfectly dry ever since.

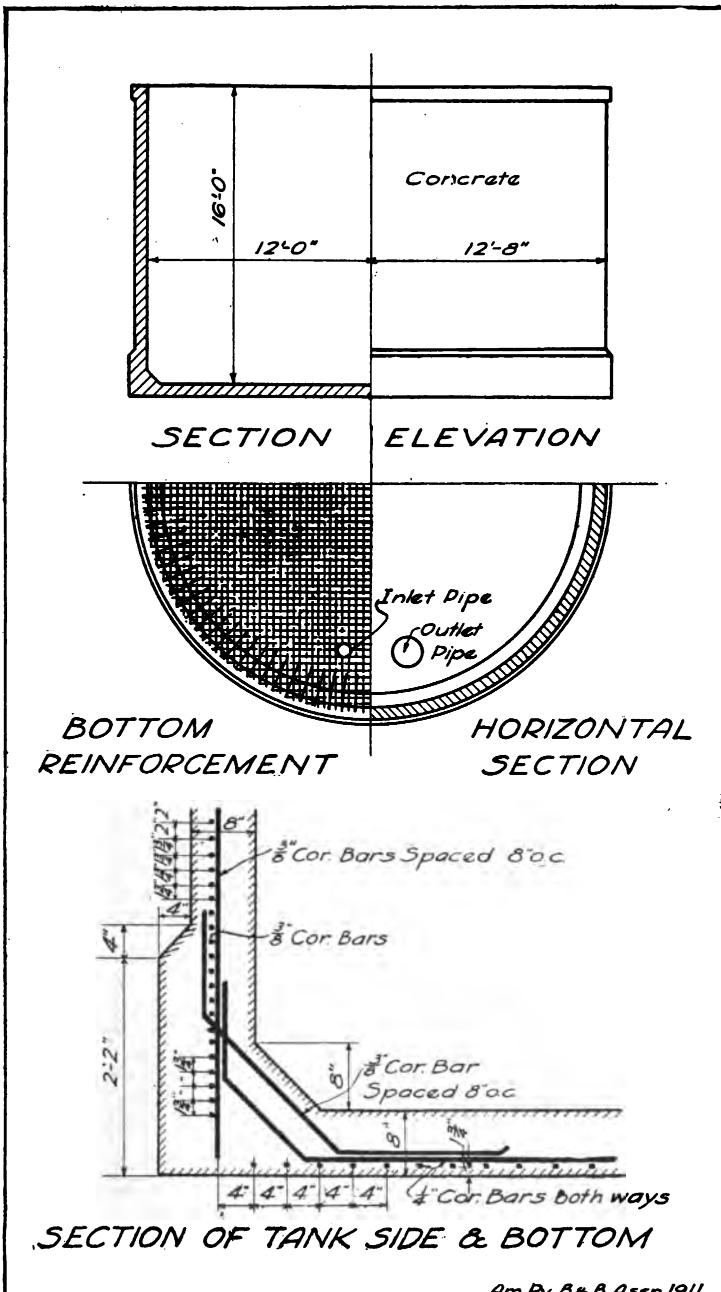
During the year 1909 the Spokane, Portland & Seattle Ry. constructed a reinforced concrete water tank 24 ft. in diameter, 16 ft. high, with a capacity of 48,000 gallons. The walls and floor are 8 in. thick, but where they join the walls are 12 in. thick for a distance of 2 ft. The joint between walls and floor on the inside of the tank is beveled, and bent reinforcing bars are carried from the floor to the walls. The concrete was of Portland



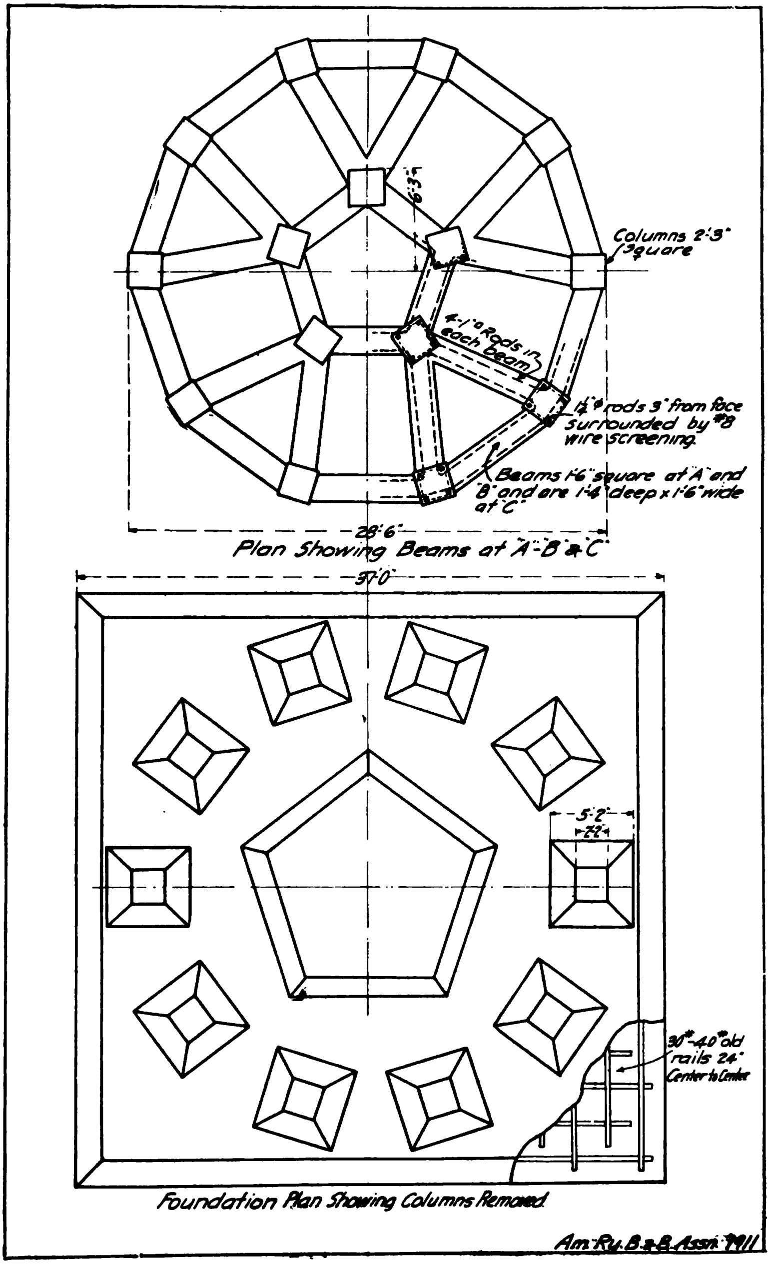
Concrete Tank at Empalme, Mexico,—Southern Pacific Co.



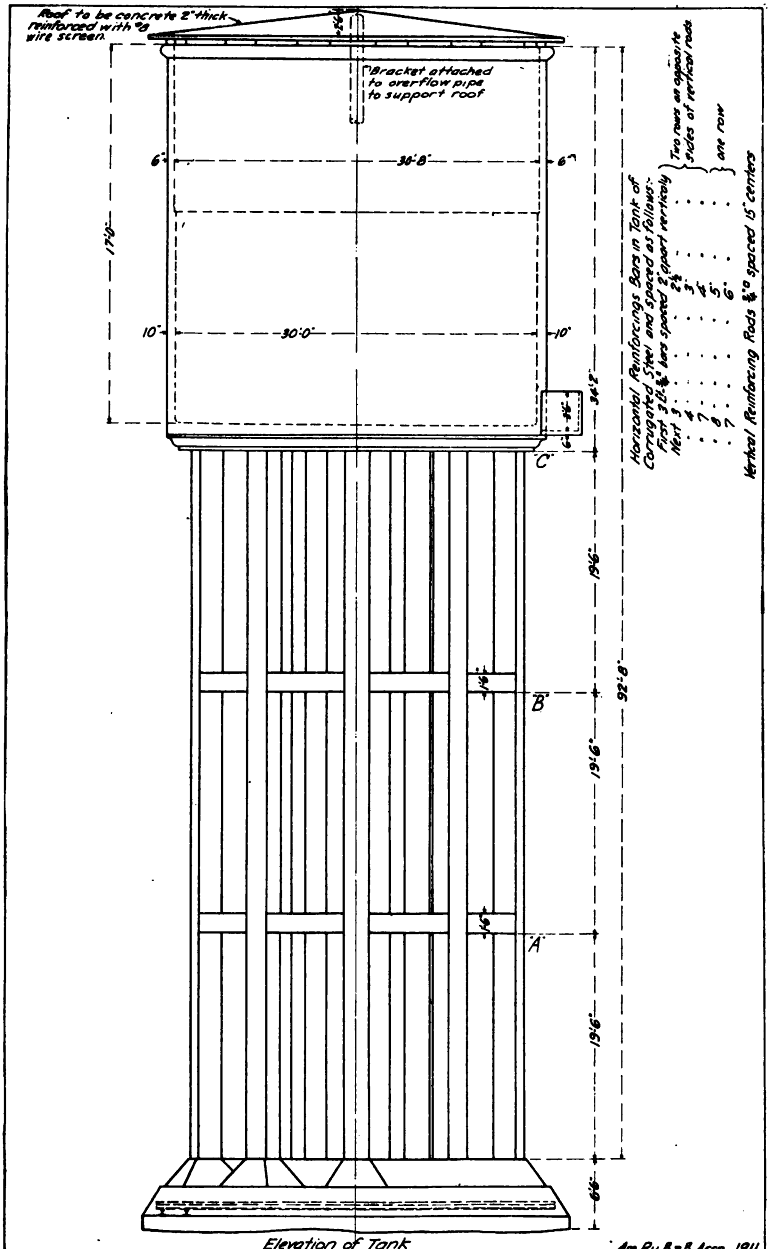
Concrete Tank at Empalme, Mexico,—Southern Pacific Co.



Concrete Tank, Spokane, Portland & Seattle Ry.



Foundation Details, Concrete Tank, Anaheim, Cal.



Concrete Tank and Tower, Anaheim, Cal.

cement, sand and stone in the proportions of 1:2:4, the stone being ¾ in. in size. The specifications required that the broken stone must be pushed back so as to leave 1 in. of mortar next to all surfaces, both inside and outside. Care was taken to compact the concrete so as to make it as nearly waterproof as possible. The illustration shows how the reinforcement was carried from the floor into the walls.

During the year 1907 a reinforced water tank on a reinforced concrete tower was built for the Municipal Electric Light Plant and Water Works, of the City of Anaheim, California, at a cost of $11,400, having a capacity of 172,000 gallons. This tank presents a very pleasing appearance, as will be noted from the illustration; and a description is covered in the following extracts from the specifications:

"Type:—A reinforced, monolithic concrete tank and tower, as shown in the accompanying drawings, which are hereby made a part of these specifications. The structure should be designed to give as attractive an appearance as possible. All corners of columns and beams are to be beveled or rounded. Forms must be of surfaced lumber where in contact with concrete, and must be true, to give as even a surface as possible.

"Capacity:—Tank is to be 30 ft. 0 in. inside diameter for 17 ft. in height and 30 ft 8 in. inside diameter for the remainder of the 32 ft. of height. The tank floor is to be 10 in. thick, with additional thickness of 16 in. in the beams. Columns each 2 ft. 3 in. square are to be arranged as shown, and connected with beams 18 in. square.

"Construction:—The excavation for the foundation is to be carried down full six feet below the ground level. If any quicksand or other treacherous soil is found at the bottom of the excavation this is to be removed to a depth of 18 in. and replaced with clay or loam. Before depositing the first concrete the ground must be thoroughly wet and then tamped. The concrete for the foundation is to consist of: One part Portland cement, three parts clean, sharp sand, four and one-half parts broken rock, or screened gravel consisting of particles varying in size from ¼ in. to 3 in. greatest dimension.

"The concrete for the columns and beams supporting the tank is to be: One part Portland cement, two and a half parts clean, sharp sand, and three and a half parts broken rock consisting of particles varying in size from ¼ in. to 2 in. greatest dimension.

"The concrete for the tank is to consist of: One part Portland cement, two parts clean, sharp sand, and two and one-half parts broken rock varying in size from ¼ in. to 1 in. greatest dimension.

"The cement is to be of some brand approved by the engineer and have a tensile strength of at least 180 lbs. per square inch when made into neat cement tests briquettes, after hardening one day in air; and a strength of 450 lbs. per square inch after 7 days. Not more than 4 per cent must remain on a 100-mesh screen, and 18 per cent on a 200-mesh screen.

"In all portions of the work care must be used to proportion the different size particles of sand and rock to prevent voids, and special care must be observed in this regard in placing material for the tank.

"The arrangement and support of the forms and reinforcing material must be such that there is no shifting of either after the concrete is in place.

"The concrete must be thoroughly and properly mixed (either by hand or machine) and wet with just enough water to show on the surface of the concrete after it is thoroughly tamped.

"The work must proceed as continuously as possible. Not more than one yard of concrete may be mixed and wet before putting into the forms, and it must not be allowed to stand more than twenty minutes before placing. Whenever the placing of concrete is stopped for more than four hours the old work must be washed clean and a thin layer of grout placed upon it before adding more concrete.

"There must be at least one tamper for every shoveler and no large quantity of concrete must be placed without thoroughly tamping.

"Reinforcing:—Reinforcing steel must be placed as uniformly as possible. All bars in tension must be lapped 12 in. and fastened together with two

Concrete Tank and Tower, Anaheim, Cal. Capacity, 172,000 Gallons.

cable clamps or other approved methods. Rods in compression must have their ends kept in line by being placed in a piece of closely-fitting pipe 12 in. long.

"General:—The forms must not be removed before 10 days after the concrete is placed, and the concrete must then be thoroughly wet once every 24 hours for 10 days.

"The tank must be provided with three outlets, as shown, a supply pipe 12 in. diameter, over-flow pipe 12 in. diameter, clean out pipe 6 in. diameter. The concrete around the supply pipe must be built up 2 in. to prevent sediment from getting into the distributing system, and the floor of the tank must slope one inch from all directions toward the clean out pipe. The inside of the tank is to receive a water proofing coat ½ in. thick, of one part cement and one part fine sand. The wall of the tank must be roughed up to receive this coat, and it be thoroughly rubbed down.

"The tank is to have a reinforced concrete cover, as shown, supported at the center by a projection from the top of the over-flow pipe. Ten spaces each 6 in. high by 30 in. long are to be left open, as shown, and covered by one layer each of 4-mesh galvanized screen of No. 10 wire and one of 12-mesh galvanized screen of No. 28 wire. Ladders must be provided to give access to the platform at the base of the tank. A hole in the cover 24 in. square must be provided with tight sliding cover, and a ladder from the platform at the base of the tank lead to this hole, to admit inspection of the interior of the tank.

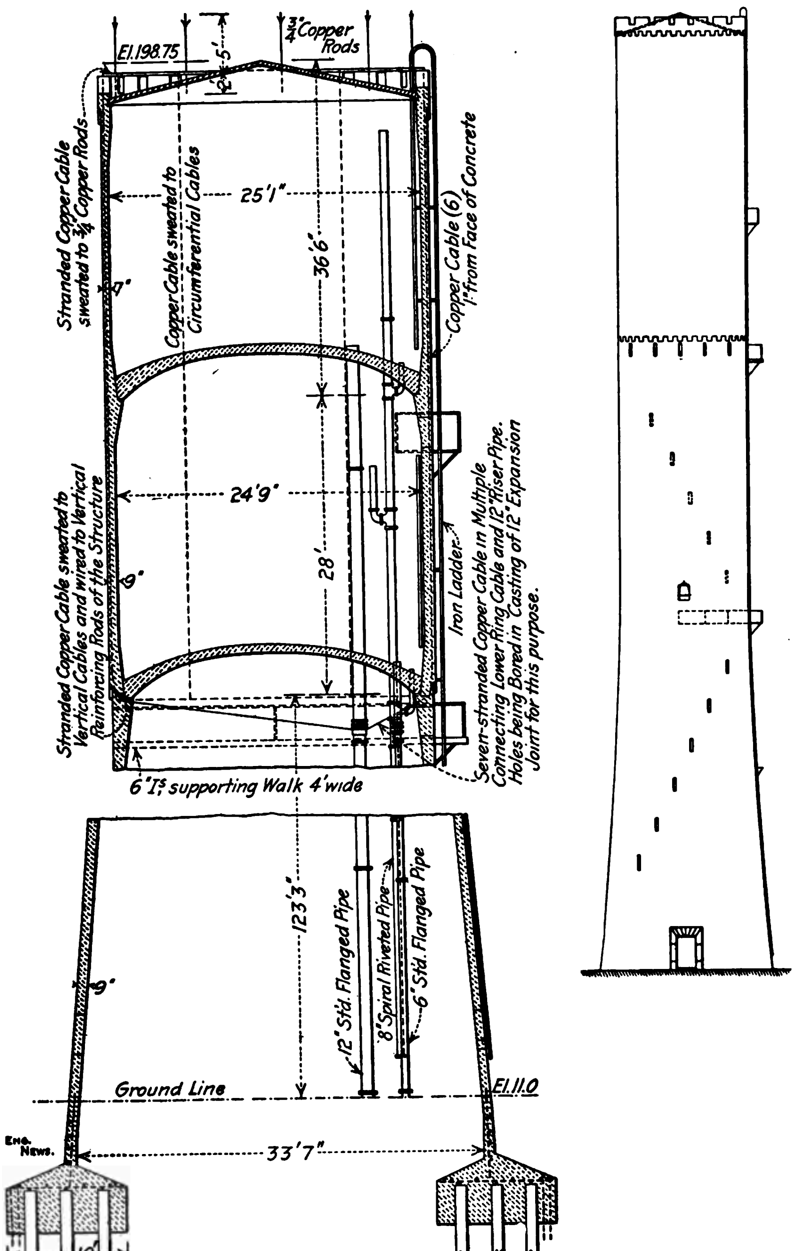
"The tank will not be accepted until it has been filled with water by the contractor and allowed to stand ten days. If by that time no cracks appear in the structure, or unequal settlement or a total settlement of more than one inch occurs, and there is no leaking of the tank more than a slight sweating and no other defects or failures are evident, the structure will be accepted by the City of Anaheim. If any defect is disclosed by this test the contractor shall have thirty days to remedy the same. If he does this so that it will stand the above test it may then be accepted by the City of Anaheim; if not he must refund the entire cost to the City."

Early this year a reinforced concrete standpipe was completed for the U. S. Naval Station at Key West, Fla., 80 ft. in diameter, 40 ft. high, with a capacity of 1,500,000 gallons, costing $19,950. It is impossible to get good water from wells in this locality, and the standpipe was built to conserve the supply of rain water falling from August to December each year. The method of reinforcement is of interest and I take the liberty of quoting from Engineering News:

"The standpipe consists of an 18-in. wire-mesh reinforced concrete foundation, with an extra depth under the side walls, and a 6-inch wire-mesh reinforced concrete bottom, integral in construction with the circular side walls. The reinforcement of these walls consists of vertical 4-inch 5.25-lb. channels, spaced 6 ft. 4⅜ ins. c. to c., for the bottom 25 ft., and 2x2x5/16-in. angles, with the same spacing for the top 15 ft., bonded together with circumferential round rods of variable size and spacing, as shown on the drawing. These circumferential rods are tied together by special clips, spaced so as to break joints, and were held to the uprights by 1/16-in. wires passed through holes punched for the purpose, in the channels and angles.

"The base concrete was 1:3:6, and all other 1:2:4 mixture. The specifications provided for bonding of the successive sections of cistern wall, which were made about 3 ft. in height, by beveled joints and by ½-in. upset end steel dowel pins 12 in. long and spaced 12 in. apart. After completion the work was smoothed down and the outside given a brush coat of cement grout. The interior, including the floor, was required to be plastered with three coats of cement mortar, after which four coats each of soap and alum washes were to be applied. Some efflorescence has appeared on the outside of the standpipe, but no leakage is as yet evident, though on account of drought a full depth test has not yet been available."

A reinforced concrete tank was recently built by the Central of Georgia Ry., at Savanna, Ga., which has several unique features and is described as follows by Mr. H. E. Sharpley, assistant to the chief engineer:



Concrete Tank, Central of Georgia Ry., Savannah, Ga.
(Cut furnished by Eng. News.)

A 150,000-gallon reinforced concrete tank was recently built at Savannah, Ga., which it is believed is the highest tank of its character in the world, the same being 187 ft. 3 in. from the ground line to the top of the parapet wall and 187 ft. 9 in. to the peak of the roof. It consists of a tapering hollow chimney-like shaft, 33 ft. 7 in. inside diameter at the ground line, tapering to an inside diameter of 24 ft. 7½ in. at a height of 66 ft. from the ground line, at which point the shaft assumes a cylindrical form and continues thus to the top.

The tanks were formed by putting in two partitions in the shaft, these partitions serving as the bottoms of the tanks, and being of reinforced concrete and dome shaped. The receptacles above the dome-shaped partitions or tank bottoms form the tanks.—The upper one having a capacity of 100,000 gallons and the lower one 50,000 gallons. The upper tank is used for the storage of water in case of fire on the terminals, and the lower tank for general use.

The structure is carried on a foundation consisting of 112 piles, with three additional piles supporting the riser and over-flow pipes; all having a penetration of 30 ft. below permanent moisture and driven 3 ft. centers in three concentric circles.

The concrete in the foundation consists of a 1:2½:5 mixture, and was poured around the piles on a mud foundation, without the use of grillage.

The reinforcement for the foundation consists of ¾ in. corrugated bars laid both radially and as concentric circles. Six of these circular reinforcing rods, together with two ½ in. metal rods 2 ft. long spaced 10 ft. apart, tie in the foundation around the piling, preventing any tendency of the foundation to spread outward. Three circles of ¾ in. reinforcing rods on top of the piling act to distribute the pressure from the radial reinforcing rods, which consist of 294 ¾ in. bars 10 ft. long laid in a horizontal position on the top of the circular reinforcement, and they are spaced 6 in. apart at the periphery. Six additional concentric circles of ¾ in. rods are laid on top of these radical reinforcing rods to still further tie in the foundation.

The foundation is 10 ft. 6 in. wide for a height of 3 ft. 9 in., from which height it tapers in a height of 22 in. to 9 in. in width at the base of the hollow shaft.

The walls of the shaft below the tank were made of a 1:2:4 mixture, and reinforced horizontally with ½ in. bars embedded near the middle of the wall, properly curved and laid in a spiral. The pitch of the spiral is one foot vertical for each complete circumference, resulting in what is practically a ring or hoop of ½ in. bars every 12 in. in height of tower. The reinforcing rods were lapped over 24 in. and wired. The vertical reinforcement was also ½ in. bars spaced 24 in. centers, lapped 24 in. and wired to the horizontal reinforcement.

At the periphery of the tank bottoms the walls of the shaft were widened to form a supporting ledge for the dome-shaped bottoms, as well as to permit of the necessary reinforcement to resist the tendency of the dome-shaped bottom to flatten out from hydrostatic pressure. This hydrostatic pressure was taken care of by using horizontal rings of ½ in. bars, each ring being made up of a sufficient number of ½ in. bars, lapped 42 in. at the joints or splices, in successive rings staggered, and the successive rings so spaced as to take up the full tensile stress when the tank is full of water; and not permitting any of the tensile stress to be taken up by the concrete.

In addition to these horizontal rings in that part of the shaft forming the wall of the tank, vertical reinforcing rods of ½ in. bars were also placed 16 in. apart. The dome-shaped bottoms and walls of that part of the shaft forming the tanks were made of 1:1½:2½ mixture. The thickness of the concrete walls of the shaft are as follows: 9 in. at the top of foundation and gradually decreasing to 8 in. at a height of 66 ft. above the ground line, which thickness continues to the widening required for the tank bottom.

The wall of the 50,000 gal. tank is 9 in. thick, and that of the upper, or 100,000-gal. tank, is 7 in.

The size of gravel used in the foundation was 2 in. and under; in the

shaft supporting the tanks 1 in. and under; and in the dome-shaped bottoms the shaft forming the tanks ½ in. and under.

The roof is conical, and it also has a tendency to flatten; that is taken care of by additional horizontal rings in the walls of the shaft in the same manner as the tank bottoms. The reinforcement in the roof consists of sheets of 3 in. mesh, No. 10 expanded metal embedded near the center of the slabs.

A portion of the shaft beneath the tanks is lighted by windows 8x30 in., arranged in the form of a spiral, each window being 8 ft. higher than the one preceding and 20 degrees in advance. In each of these window openings a pane of double thick glass has been placed and securely fastened with neat cement mortar. Three large windows and a panel door have been provided at the bottom of the tower, to make that portion serviceable as a storage room. The whole structure is neat and pleasing in appearance and resembles somewhat an ancient tower.

The riser pipes are carried up inside the tower and directly through the bottoms of the tanks. Access is had to the tanks by an iron ladder, which runs on the outside of the tower from the bottom to the top and extends down on the inside to the bottom of each tank. Openings are provided at three places along this ladder, with platform and guard rail to permit safe passage in and out. The lower opening, about 75 ft. above the ground, is at the level of the fire alarm bell and its electro-mechanical striking apparatus. The second opening is just below, and the third just above the 50,000-gal. tank. In addition there is an opening through the roof to the 100,000-gal. tank.

Lightning protection is provided by 10 rods of ¾ in. solid copper, set 2 ft. in the concrete, and extending 5 ft. above the parapet, each of these rods terminating at the upper end in a three-point aigrette. The lower ends are wired to the reinforcing and in addition are sweated to a stranded copper wire cable. This forms a complete circle just above the concrete, and is in turn connected to a similar cable embedded in the concrete just at the base of the lower tank. The bottom cable is connected to the expansion joint of the 12 in. riser pipe which acts as a ground.

The tanks are supplied by electrically-driven pumps, and these are controlled automatically. In addition, metal indicators are provided on the outside to show correctly the amount of water in the tanks.

It might be interesting to know that when water was first turned into the tanks a considerable number of small leaks developed in the sides, evidently due to not using sufficient care in cutting the wires which held the forms together. These, however, rapidly took up and in a couple of months the tanks became entirely water-tight.

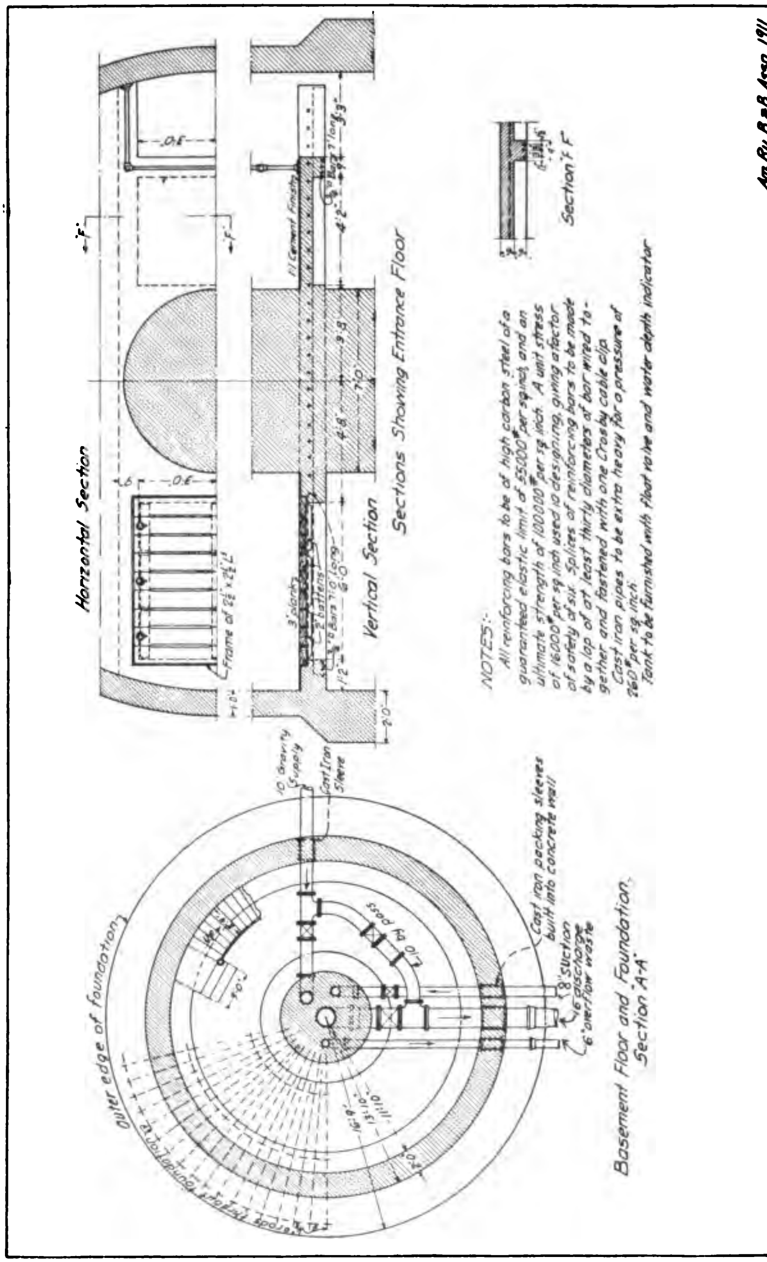
The concrete work was done by the Piedmont Construction Co., Atlanta, Georgia. The average force employed was 16 men, including the foreman, and a carpenter. The metal forms which were used are of patented design. Only one form or course was poured each day, the remainder of the time being spent in removing the forms set the day before and putting them in place for the next pouring.

The entire work was carried out under the railway company's chief engineer, Mr. C. K. Lawrence.

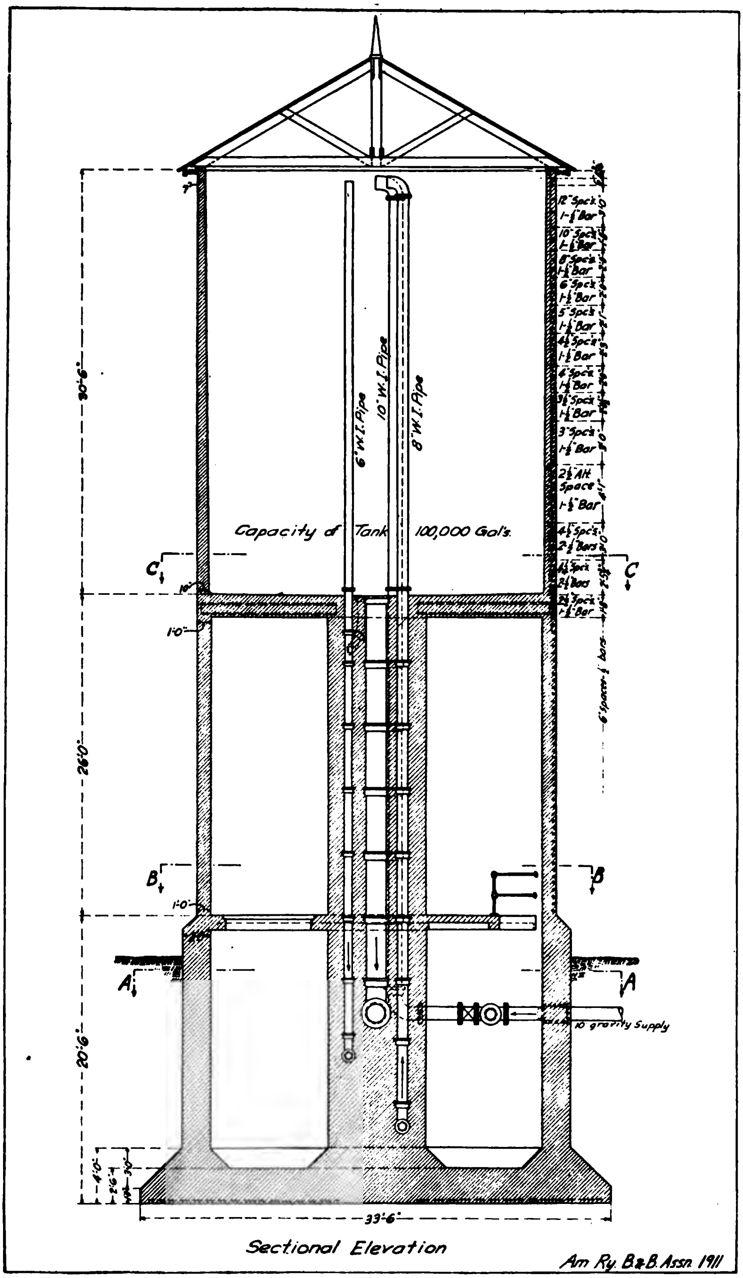
The Baltimore & Ohio R. R. completed this year a reinforced concrete water tank 24 ft. in diameter and 30 ft. 6 in. deep, having a capacity of 100,000 gallons, at Sir John's Run, W. Va., at a cost of about $7,500, exclusive of piping. Mr. W. F. Strouse, Asst. Engineer, sent a blue print and makes the following report:

The bottom of the tank is thirty feet above top of rail of the adjacent main tracks. Below the track level a basement was provided in which is located a pump, arranged for taking water from the Potomac river in case of failure of the gravity supply. The space between the track level and the bottom of the tank is arranged for a storeroom for supplies required about the coaling and water stations. The enclosed plan fully illustrates the arrangements and shows details of construction.

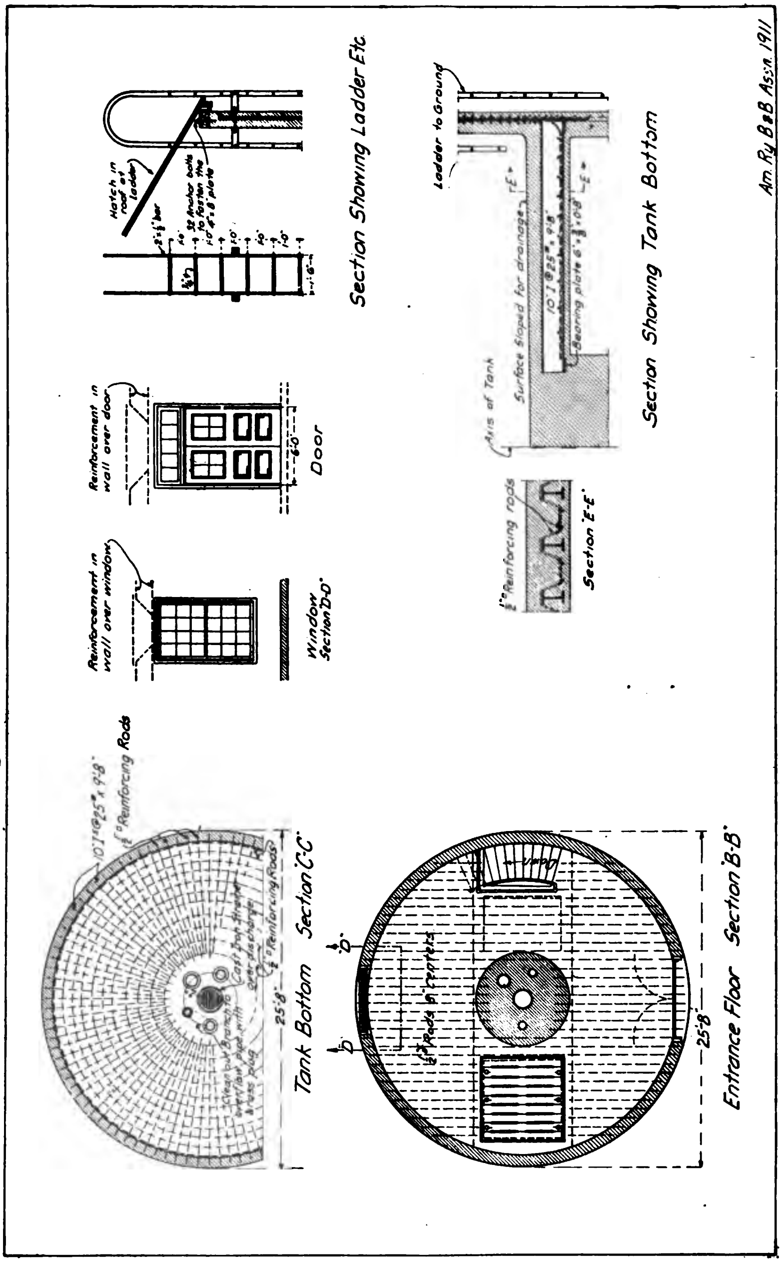
The foundation and walls below the track level were constructed of plain concrete, of a 1:3:5 mixture. All work above the track level was rein-



Concrete Tank, Sir John's Run, W. Va., B. & O. R. R.



Concrete Tank at Sir John's Run, W. Va., B. & O. R. R.



Details of Concrete Tank at Sir John's Run, W. Va.—Baltimore & Ohio R. R.

forced concrete of a 1:2:4 mixture, the ingredients being Portland cement, crushed washed glass sand and crushed limestone which would pass a one inch ring. The walls were moulded in forms constructed of sheet steel after patents of the Steel Concrete Construction Company, and they produced a smooth surface except at the horizontal joints, at intervals of about five feet, where a slight lipping occurred due to a small discrepancy between the shape of the top and bottom edges of the forms. The bond at the horizontal joints was formed by cleaning the top surface of each section with wire brushes and clean water. The surface was then covered with a thin grout of hydrated lime, Portland cement and sand, followed by a coating of mortar before the concrete for the next section was poured.

Corrugated steel bars spaced and bent to proper radius, as shown on the plan, were used for the reinforcement. They were lapped 30 diameters and wired together with No. 12 annealed wire at all joints.

The waterproofing consisted of hydrated lime mixed with the cement in the proportion of not to exceed 5 per cent by volume. The exterior walls were painted two coats of Bay State cement coating of a light gray color.

Mr. H. H. Kinzie, Supervisor B. & B., N. Y., N. H. & H. R. R., sends the following interesting report of experience with a standpipe built for the town of Attleboro, Mass., 50 ft. in diameter and 100 ft. high, that is giving entire satisfaction:

The Aberthaw Construction Company, of Boston, Mass., erected this standpipe, and it is said that it is one of the largest reinforced concrete standpipes yet constructed. The walls are 18 in. thick at the bottom and 8 in. at the top. The foundation extends to a solid subsoil at a depth of 7 ft. The bottom pan and the walls are connected by a reinforced fillet of good size. The concrete used was a 1:2:4 stone mixture. The horizontal steel reinforcement consisted of 1½ in. plain round bars in double vertical rows extending from the ground to a height of 60 ft. Above this a single row was used which, at 81 ft., was reduced to 1⅛ in. diameter. The steel is protected throughout by from 2½ in to 3 in. of concrete. The spacing of the double horizontal steel members varies from 3¾ in. c. to c. to 8 in.; that of the single 2½ in. row, 4⅛ in. to 6 in.; and that of the 1⅛ in. row, 3½ in. to 6⅝ in., on centers. These bars were delivered in lengths of 56½ ft., necessitating the use of three to span the circumference with an overlap of 30 in., each, with which to clamp them together. The vertical reinforcement consists of fifteen channels, equally spaced. These were drilled at intervals for the reception of short ½ in. bars upon which to rest the horizontal bars.

On Dec. 27, 1905, the new standpipe was put into commission and we continued to use the same until May 15, 1906. The leaks during that time were very trifling, although during extreme cold weather there was noticed a peeling off on the outer surface at certain points, beginning five feet from the bottom of the tank and extending to a point about 15 ft. above it. This was apparently caused by pockets or cavities that must have existed on the outside of the steel, probably caused by the slight moving of the forms when the concrete was being placed.

About May 15, 1906, the Aberthaw Construction Company began the plastering on the inside of the standpipe. The first coat had 2 per cent of lime to one part cement and one part sand; the other three coats were composed of one part sand and one part cement. This was floated until a hard, dense surface was produced. Then this surface was scratched to receive the succeeding coat. This work was done by experts in that line.

Prior to the plastering the entire inside of the standpipe was thoroughly cleaned and then picked. This was done to insure the bonding of the cement plaster to the surface. There were four coats of plaster put on, and they felt reasonably sure that it would be perfectly tight, as great care was used in applying the coatings. Upon filling the standpipe, however, it was found that the work did not give the result expected, as the builders had felt positive that they should have an absolutely water-tight structure.

At the time the inside work was being done the outside, where the cement had scaled off from the effects of frost, was repaired by digging around the outside row of steel reinforcement, putting on iron clips made of ¾x1⅛ in.

iron bolted through, and then cement was forced into the cavities around these clips by throwing it at a distance of four or five feet to insure the filling of the voids. This process was continued until the cement covered the entire outer surface, so that further plastering could be perfectly bonded. On this surface was placed expanded metal, forced over the clips that stood out horizontally, and then a coat of plaster was carefully troweled over the surface of this metal, and next a coat of metal placed outside of that plastering, the ends of the clips being turned at right angles to hold the same in place. After this the final outside coat was applied, thus making a very firm and compact surface equal to any part of the structure.

After noting the result of the interior plastering, they were satisfied that some other method must be used to make the standpipe perfectly tight under the 100 ft. head, at the same time realizing that in a warmer climate they should not hesitate to accept it as it was. On consulting with their engineer and contractor they decided to coat the inside with what is known as the "Sylvester Process" wash. I presume many of you are familiar with the same, but for the benefit of those who are not, I will give the formula used on this standpipe:

Dissolve ¾ pound castile soap in one gallon of water. Dissolve one pound pure alum in eight gallons of water. Both must be thoroughly dissolved. Before applying to the walls, the surface must be perfectly clean and dry. The temperature must be about 50 degrees, Fahrenheit. First, apply the soap at boiling temperature with a flat brush, taking care not to form a froth. Wait 24 hours, so that the solution will become dry and hard upon the walls, and then apply the alum in the same way, at a temperature of 60 to 70 degrees, Fahrenheit. Wait 24 hours, and repeat with alternate coats of soap and alum.

On the Croton work four coats of each solution rendered the walls impervious. According to report a pound of soap will cover about 37 sq. ft., and one pound of alum will cover about 95 sq. ft. Water was admitted to the tank as soon as the last coat became hard and dry. This solution has been used with good success on a number of reservoirs, not exceeding a 40 ft. head, making them absolutely tight.

In order to test this process they decided to try 35 ft. of the standpipe from the bottom up. After applying four coats of the mixture they filled the standpipe full at 100 ft. head and they found there were only four leaks in the 35 ft. coated. On account of this success they decided to apply four coats more to this same surface, that making eight coats from the bottom up to 35 ft., and above that distance four coats. The result was very satisfactory, but still the standpipe was not absolutely tight. They then decided to apply five more coats over the entire surface, thus making thirteen coats for 35 ft. and nine for the rest of the structure. On Oct. 28 the standpipe was filled and found to be practically tight, and has given them very little trouble, if any, since it was put into service.

In 1909 the Ann Arbor Gas Company, at Ann Arbor, Michigan, built two rectangular ammonia storage tanks of reinforced concrete, having a common wall. The larger tank is 40x10 ft. 1½ in., with a capacity of 27,850 gal., and the smaller is 30x8 ft. 1½ in., with a capacity of 17,000 gal. Both tanks are 13 ft. deep. In the building of these tanks quick sand and water were encountered and it was necessary to lay drains under the entire tank bottom and pump water during the period of construction.

These tanks were reinforced with trussed bars laid in both directions and bent rods carried from the walls into the bottom. After completion the inside was white-washed with a cement coating and after that plastered with a thin coat of cement mortar, consisting of one part of sand to one part of cement. These tanks have proven very satisfactory and are apparently absolutely water tight. The cost of both tanks was about $1,700.

The Metal Concrete Construction Co., of St. Louis, completed a reservoir for the Virginia Electric Power & Water Co., at Virginia, Minn., last fall, 45 ft. diameter, 21 ft. high. It is built partly above and partly below the ground level, and during the winter the exposed portion was covered with a layer of clay next to the tank, a layer of cinders above that and then another

layer of clay, making a total thickness of 18 inches. When the covering was removed in the spring the tank showed no sign of injury by frost, although the winter was severe. As far as can be seen, the concrete is perfectly water tight.

On the eastern division of the Pennsylvania Lines, between Alliance and Galilee there may be found a number of reinforced concrete tanks on reinforced concrete posts.

On Jan. 1, 1909, the Grand Rapids & Indiana Ry. put into service at Elmira, Mich., a tank of 50,000 gal, capacity, having a reinforced concrete substructure and floor with wooden staves. It has been in service continuously since it was erected and is reported as giving the best of satisfaction. While not exactly in line with the subject, it is included in this report as an item of interest. The joint between the wooden staves and the concrete floor was first calked with oakum and then filled with hot pitch.

There is no question but that interest in the use of reinforced concrete in the construction of water tanks is increasing. The committee has had many replies from members of this association stating that they have had no experience in this line, but that the matter has been under consideration.

Mr. C. H. Fisk, chief engineer of the Tennessee, Alabama & Georgia Ry., writes that he is interested because his road is contemplating the erection of ten such structures, and he may be able to add some valuable information in the future.

List of some of the principal reinforced concrete tanks, standpipes and reservoirs built in the U. S. with reference as to where detailed information may be obtained.

1899—Little Falls, N. J. Standpipe. 10 ft. dia., 43 ft. high. Cap. 25,000 gal. Trans. Am. Soc. of C. E., Vol. 50, p. 454; Vol. 54, Part E., p. 433.

1903—Milford, Ohio. Standpipe. 15 ft. dia., 81 ft. high. Cap. 93,000 gal. Engr. News, Vol. 51, p. 184, Feb. 25, 1904. Engr. Record, Vol. 49, p. 382, March 26, 1904.

1903—Fort Revere, Hull, Mass. Standpipe. Octagonal Tower, 33 ft. dia., 84 ft. high. Tank 20 ft. inside dia., 50 ft. high. Cap. 118,000 gal. Journal of New England Water Works Ass'n, March, 1905. Engr. News, Vol. 52, p. 596, Dec. 29, 1904. Engr. Record, Vol. 48, p. 218, Aug. 22, 1903. Municipal Jour. & Engr., Vol. 21, p. 543, Dec. 5, 1906. Cement Age, p. 353. Feb., 1905.

1904—Attleboro, Mass. Standpipe. 50 ft. dia., 100 ft. high. Cap. 1,500,000 gal. Engr. News, Vol. 57, p. 212, Feb. 21, 1907. Engr. News, Vol. 62, p. 199, Aug. 19, 1909. Cement & Engr. News, Vol. 19, p. 138, June, 1907. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 402, June, 1911. Engineering-Contracting, Vol. 35, p. 560, May 17, 1911.

1905—Hampton, Va. Two Tanks. Each 26 ft. 6 in. dia., 16 ft. high. Cap. 66,000 gal. Trans. Am. Soc. of C. E., Vol. 54, Part E, p. 433.

1905—Bordentown, N. J. Water Tower. Engr. Record, Jan., 1906, p. 39.

1906—Anaheim, Cal. Tank. 26 ft. dia., 30 ft. deep, resting on 60 ft. concrete tower. Cap. 172,000 gal. Engr. Record, Vol. 56, p. 203, Aug. 24, 1907. Municipal Journal & Engr., Vol. 28, p. 366, March 9, 1910, and p. 527, April 13, 1910.

1906—Kansas City, Mo. Tank. On tower above warehouse. Cap. 25,000 gal. Engr. News, Vol. 58, p. 82, July 25, 1907.

1906—Waltham, Mass. Standpipe. 100 ft. dia., 37 ft. deep. Cap. 2,000,000 gal. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 421, June, 1911. Engr. Record, Jan., 1907, p. 32.

1907—Lincoln, Me. Tank. 32 ft. dia., 16 ft. deep. Cap. 108,000 gal.

1908—Atlanta, Ga. Tank. Resting on chimney-like shaft. Cap. 100.000 gal. Engr. News, Vol. 61, p. 22, Jan. 7, 1909. Engr. Record, Vol. 59, p. 9, Jan. 2, 1909.

1908—New Haven, Conn. Standpipe. 50 ft. dia., 25 ft. high. Cap. 375,000 gal. Engr. News, Vol. 59, p. 191, Feb. 20, 1908.

1909—Empalme, Sonora, Mexico. Standpipe. 30 ft. dia., 90 ft. high.

Cap. 475,000 gal. Engr. News, Vol. 62, p. 635, Dec. 9, 1909. Mun. Jour. & Engr., Vol. 28, p. 828, June 8, 1910. Railway Age-Gazette, Vol. 47, p. 469, Sept. 10, 1909.

1909—San Francisco, Cal. Two Tanks. Each 17 ft. dia., 20 ft. deep. Cap. 32,400 gal. 14 ft. above ground carried on 4 in. reinforced concrete slabs. Engr. Record, Vol. 61, p. 726, June 4, 1910.

1909—Cajame, Sonora, Mexico. Tank. With dome supported bottom. Cap. 60,000 gal. Engr. Record, Vol. 61, p. 248, Feb. 26, 1910.

1909—Montview Station, Va. Tank. 30 ft. dia. Cap. 100,000 gal. Engr. Record, Vol. 60, p. 447, Oct. 16, 1909.

1909—Bridgewater, Mass., State Farm Standpipe. 30 ft. dia., 78 ft. high. Cap. 413,000 gal. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 399, June, 1911.

1909—Manchester, Mass. Standpipe. 50 ft. dia., 72 ft. high. Cap. 1,060,000 gal. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 399, June, 1911.

1909—Lisbon Falls, Me. Standpipe. 50 ft. dia., 62 ft. high. Cap. 913,000 gal. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 398, June 1911.

1909—Spokane, Portland & Seattle Ry. Tank. 24 ft. dia., 16 ft. high. Cap. 48,000 gal. Ry. & Engr. Review, Vol. 49, p. 852, Sept. 25, 1909.

1909—Ann Arbor, Mich. Two Rectangular Tanks. 10 ft. x 40 ft., 13 ft. deep. Cap. 27,850 gal.; 8 ft. x 30 ft., 13 ft. deep. Cap. 17,000 gal. Engr. Record, Vol. 64, p. 481, Oct. 21, 1911.

1910—Westerly, R. I. Standpipe. 40 ft. dia., 70 ft. high. Cap. 650,000 gal. Canadian Engineer, Vol. 19, p. 430, Sept. 29, 1910. Engr. Contracting, Vol. 34, p. 284, Oct. 5, 1910. Engr. Contracting, Vol. 36, p. 371, Oct. 11, 1911. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 404, June, 1911. Proc. Am. Soc. C. E., Vol. 37, p. 1025.

1910—Rockland, Mass. Standpipe. 46 ft. dia., 104 ft. high. Cap. 1,300,000 gal. Jour. of Ass'n of Engr. Soc., June, 1911.

1910—Cherry Valley, Mass. Standpipe. 40 ft. dia., 21 ft. high. Cap. 200,000 gal.

1910—Rockdale, Mass. Standpipe. 40 ft. dia., 21 ft. high. Cap. 200,000 gal.

1910—Kensington, Conn. Reservoir. 50 ft. dia., 21 ft. high. Cap. 300,000 gal. Engr. Record, Vol. 63, p. 183, Feb. 18, 1911.

1910—Waverly, Ohio. Standpipe. 22 ft. dia., 82 ft. high. Cap. 120,000 gal. Engr. Record, Vol. 64, p. 137, July 29, 1911. Cement Age, Vol. 13, p. 18, July, 1911.

1910—Virginia, Minn. Reservoir. 45 ft. dia., 21 ft. deep. Cap. 250,000 gal.

1911—Ashland, Mass. Standpipe. 40 ft. dia., 32 ft. high. Cap. 300,000 gal.

1911—Key West, Fla., U. S. Naval Station. Standpipe. 80 ft. dia., 40 ft. high. Cap. 1,500,000 gal. Engr. News, Vol. 65, p. 492, April 20, 1911.

1911—Savannah, Ga. Tank. Tower 187 ft. high tapering from 35 ft. dia. at ground line to 25 ft. in dia. at top. 2 water reservoirs, one above the other. Total cap. 150.000 gal. Engr. News, Vol. 66, p. 260, Aug. 31, 1911.

1911—Sir John's Run, W. Va. Tank. 24 ft. dia., 30 ft. 6 in. high. Cap. 100,000 gal.

Reference Books.

"Concrete Construction, Methods and Costs," by H. P. Gillette and C. S. Hill. "Reinforced Concrete for Standpipes and Tanks," by Charles B. Burdick. "Water Storage in Elevated Tanks and Standpipes," by H. E. Horton.

Journal of the Western Society of Engineers, Vol. 14, p. 129, June, 1909. "Concrete and Reinforced Concrete Construction," by Homer A. Reid. "Concrete—Plain and Reinforced," by Taylor & Thompson. "Hand Book of Cost Data," by H. P. Gillette. "Engineer's Pocketbook of Reinforced Concrete," by Lee Heidenreich.

DISCUSSION.

The President:—We will discuss the report of the committee on concrete tank construction. Mr. F. E. Weise is chairman.

Mr. J. H. Markley:—Has the committee any information in regard to cost, as compared with the cost of iron and wooden tanks?

The President:—I believe they have.

Mr. Weise:—In some of the descriptions that accompany this paper, statements of the cost have been given, but the committee did not go into the matter of cost with a view to making a complete analysis of it, because the conditions in the individual cases that we were able to get at vary so much that we could not obtain any good figures, or figures that one could apply somewhere else. It is generally admitted, however, that the reinforced concrete tank costs considerably more than either a steel or wooden tank, but its permanent construction and the low cost of maintenance is the big argument in its favor.

The President:—Now Mr. Markley, we would like to hear from you; Mr. Aaron Markley.

Mr. A. S. Markley:—As I have never seen a concrete tank, I hardly know of any argument for or against it. It is something new to me and I am just waiting to hear what the others have to say. I may have something to say on the subject later.

The President:—Are there any other members present who are familiar with this form of construction?

Mr. Strouse:—I sent to the committee a drawing and a brief description of the tank that was constructed for the Baltimore & Ohio R. R. I do not know that I have anything more to say than was given in that description. The tank has been in use only some three or four weeks, and we have not had time to determine definitely on the waterproofing features. So far, it has not leaked. It has sweated a good deal and, of course, has discolored the outer surface. In this particular tank the forms were of interest to me, in that two concentric metal forms were used and a section of about five feet was constructed at a time. As the concrete hardened, it was allowed to stand about a day, the forms were loosened and raised up and supported; that is, separated by separators which were removed as the next section of concrete was placed. In the report I made mention of the method of joining the new concrete to the old.

The only effort made there to get a perfect bond was to clean the top surface of the previous section thoroughly with wire brushes, and then to place on that surface a grout of cement and a small quantity of hydrate of lime. Each section required about two days; that is to say, one day for filling the section and one day for the material to harden and to move the forms. The water was not turned into the tank for about thirty days, and when it was first turned on several small leaks developed, but lately nothing has shown up that would indicate that the tank is not substantially water tight. As I say, a small amount of moisture has gathered on the outside, that has followed down the walls and discolored the paint that was applied to the outside, but I am of the opinion that this particular style of tank construction is good; it is bound to be reliable and economical. Of course it is more expensive than wooden or steel tanks at first cost, but I think it will be cheaper in the long run.

Mr. O'Neill:—I would like to ask the gentleman if the leaks developed at the meeting points of the partly dry joints, or did they develop through the body of the concrete that was deposited during the day.

Mr. Strouse:—Apparently the moisture comes through the concrete indiscriminately; it don't seem to come through at the joints any more than at any other place.

Mr. O'Neill:—Tell us what the mixture was.

Mr. Strouse:—One to four, with approximately five per cent of hydrate of lime.

Mr. O'Neill:—How wet was that mixture?

Mr. Strouse:—Quite wet—so that in pouring it could be thoroughly stirred around.

Mr. O'Neill:—It would appear, then, that we would need something in the way of waterproofing besides a good, fairly rich mixture of concrete, in order to hold water.

Mr. Strouse:—I have always felt so; yes, sir.

Mr. O'Neill:—I too think so.

Mr. Sheldon:—I notice that in most of those tests it says that sharp sand shall be used, without designating whether it shall be coarse, fine or medium. There is a very great difference in the character of the voids in sand. What we call very fine sand has voids of nearly 50 per cent. A clean sand of varying texture, running rather to the coarse, will sometimes have as low as 10 per cent of voids. This fact might have a bearing on the quantity of cement required and also on the waterproofing qualities of the tank. In oth-

er words the texture of the sand used is important. I think the Universal Portland Cement Co. has made some exhaustive tests with different grades of sand and it might be interesting to get the result of those tests. I think they have found also that too little moisture is objectionable; and so is too much; so that when the water has evaporated, the space occupied by it is there and will be filled by other water when the tank is full. I think that it is possible to have the mixture too wet, as well as too dry.

Mr. Strouse:—We used what I think was termed No. 3 sand from a sand works right in the vicinity of where this work was done. It is really a glass sand. The rock is excavated from the hills and crushed and washed, and in the disposition of this sand they have several grades: one a very fine sand that is used by the glass companies, and another that is considerably coarser and not quite as clean as the glass sand. We used sand that had a slight amount of coloring matter in it, and of a grade that is not generally used by the glass manufacturers. I would say that the sand is probably of the character that Mr. Sheldon has in mind—a sand that contains quite a quantity of very fine particles resulting from the operation of crushing it; and then, with that, a coarser grade.

The President:—Has some one else any direct information or experience in regard to that type of construction?

Mr. Weise:—Some inquiries have been made regarding the thickness of the walls. In the first place, before we leave the sand question, I notice that in every specification that is given the proportions of cement, sand and gravel vary. I think that is largely due to local conditions; that the people who have it in charge will vary their proportions according to the material they have to work with. Sometimes one cannot get just the kind of sand that is wanted. I know that on our road, the Chicago, Milwaukee & St. Paul Ry., we are obliged to vary the proportions because we sometimes cannot get the kind of material desired without hauling it long distances.

In the matter of thickness of walls there is much difference of opinion. In some cases walls are made very thick, while in other cases they are very thin. There are shallow tanks where the walls are only three inches thick at the top and six inches at the bottom, and they may vary from six to ten inches at the bottom. In some of the higher towers the walls are as thick as 18 inches at the bottom. That is a matter of design and has to be figured out by the individual who is building the tank. It is usually allowed that the reinforcement will take care of the tension or stress in the walls, and

they don't figure very much on the strength of the concrete to resist tension, because, where the depth of water gets to be about 50 feet or so, the pressure exceeds the tension that the concrete will stand.

The usual experience leads us to this, that the tendency of the tank, when it is filled with water, is to expand; and, naturally, where the pressure is great enough, the concrete will have to give to a certain extent and will form very minute cracks, sometimes very close together; in fact the cracks are so small that they cannot be seen with the naked eye, and can be observed only after the tank has been emptied by noticing little lines of water along the surface of the concrete. These cracks, while they are not serious, allow some water to seep through, but after a while these spaces fill up, and in most of these descriptions you will find that during the first few weeks there was a slight seepage at the base of the tank, which afterwards disappears.

Mr. J. H. Markley:—I do not wish to criticise Mr. Strouse's method of putting up a tank, but if I were doing it I believe I would make the concreting continuous, and not stop until the entire volume was poured and the tank completed. There is a danger in uniting new and old concrete that no man can foresee or foretell. Of course there are some who can do that and do it properly, while there are a great many who cannot. It can be done by erecting either the outside or inside casing clear to the top, and in either case there is a section of two, three or four feet, just high enough so that the workmen can spread down in and keep adding to the wall as they build up, and keep that going continuously until the tank is completed.

I do not recall that any one mentioned using washed sand, which is the kind that should be used in work of this character. Clay and other foreign matter should be excluded. Clay would be especially dangerous in a structure of this kind, while in heavy work it might not be so considered.

Mr. Strouse:—What Mr. Markley has said in regard to continuous operation might apply in shallow tanks. I am somewhat in doubt, however, as to the result he would obtain where the tanks were deep. The tank in question was 30 feet high, and I am of the opinion,—in fact, I am quite well satisfied,—that if the forms had been placed at one time and had been filled entirely from the top, that we would have gotten poor results. My reason for this belief is that a few years ago we had a piece of work where deep girders were covered with concrete. Reinforcing rods ran along the side of the girder, through which were passed stiffeners. The forms were

built the entire depth of the girder, about 10 feet. Concrete was poured in from the top, and it was supposed to have been distributed evenly along the length of the girder. Some six months or a year after this work had been completed we discovered some cracks forming along the bottom of the girder, on the lower flange. Upon investigation, we found that the material encasing the bottom of the girder was composed principally of sand and cement, with very little or no stone. Apparently, in pouring the concrete to the depth of ten feet through the reinforcing rods, the stone had been prevented from following down with the concrete, and the result was that we got plenty of stone in the upper portion of the structure, but practically none in the bottom, and, for some reason or other, the white substance that collects on the surfaces of freshly placed concrete, had collected at places in the bottom portion of this work, which rendered the concrete practically useless. We had to remove a great deal of it, and I am very strongly of the belief that if an effort were made to pour concrete from the top for a depth of even 20 feet, that the same thing would happen.

I would say further that this particular construction was cheapened by the use of the steel forms. A section about five or five and a half feet was used and the taper was formed by placing thin sheets of metal over the joints and tightening up or loosening the bolts to the proper perimeter. When the work was completed, the forms were taken down and they will be good for the building of a great many tanks, which, of course, will cheapen the cost of other tanks to be built by the concern that constructed the one for our road.

Mr. J. H. Markley:—Mr. President, I believe that Mr. Strouse misconstrued my meaning. It was my idea to use two, three, or four sections at a time and keep building up, and not to pour it from the top. I had occasion two years ago to encase a pier thirty feet high and eighteen inches thick with concrete, and I used that method in doing the work. We began in the morning and kept on continuously till the second morning, when the work was completed. We experienced no trouble whatever and found no evil results. I believe that could be accomplished with proper bracing up, in the case of a tank, using the movable sections either on the inside or outside and make the fall of the concrete not so far as it would be from the top, say three, four or five feet.

Mr. O'Neill:—I would like to ask, if the small cracks developing in the concrete would not be disastrous to the steel reinforcement? It seems to me that it would be if the water came in contact with the steel that we get nowadays for that purpose.

Mr. Weise:—I do not know. That is a part of the subject that nobody mentioned and I have not thought of seriously, but the cracks that I spoke of, that develop from expansion at the bottom, and the concrete is stressed beyond what it will stand, are very small, infinitesimally small; in fact so small that one cannot notice them; only that after the tank is empty, one can notice along the surface, little wet lines that show where the water is oozing out because the concrete is coming back into place. I don't think that enough water is in there to do any harm to the steel, as those cracks gradually fill up with sediment or deposits from the water. There is a chance, however, that if the concrete is not properly placed, little pockets will form along the line of reinforcement that may eventually result in the corrosion of the steel or result in cracks larger than those I speak of, but that would be owing to a fault in workmanship.

The President:—A relative of mine designed a tank in Wisconsin for an industrial concern, and, as we all know, industrial concerns usually take up such things quicker than railroads do. This tank was about sixty feet high—thirty feet in the ground and thirty feet above ground. The portion under ground was not reinforced, but that above ground was. The tank is giving excellent service. It was about twenty-four feet in diameter. I cannot tell you anything about the thickness of the walls. I have seen it only once and did not pay much attention to it.

What is the pleasure of the convention? Is it your desire to continue the discussion of this report, or shall we drop it here and continue the subject for next year? We all agree, I think, from the discussion that we have had, that the construction of concrete tanks is rather in its infancy, as yet, and that developments are coming right along; that is, it is a very live subject for us to continue to investigate.

Mr. J. H. Markley:—I believe it would be wise to continue it.

The President:—Will you make that in the form of a motion?

Mr. Markley:—Yes sir.

The President:—It has been moved and seconded, gentlemen, that this subject be continued for further investigation. I would suggest to the incoming president that he retain Mr. Weise as chairman of that committee.

The motion was carried.

Subject No. 9.

BRICK VENEER FOR STATION BUILDINGS.

REPORT OF COMMITTEE.

The committee sent out a letter to members of the association and others asking what results they had secured from using brick veneer for station buildings. The replies indicate that but very few roads use brick veneer to any extent for this purpose, and a large number advise that they have not had any experience with that type of structure. Several members of the committee have had no experience with brick veneer, and one who had some experience has had considerable trouble with the veneer jarring loose from the wood work, especially around the window and door frames, on account of the vibration from passing trains and the generally severe service a station building has to withstand.

Taking into consideration the cost of lumber and the additional expense for a suitable foundation which would withstand the vibration caused by the passing of high-speed trains, many of the members are of the opinion that the saving of the cost of brick veneer over that of a solid brick structure would not justify veneering. This also brings up the question of the advisability of placing a brick veneer building on an expensive foundation.

As for fire protection, it is not considered that brick veneered buildings are very much superior to ordinary frame structures, as but a small percentage of fires that damage or destroy buildings have their origin in the outside walls.

The Toledo, Peoria & Western Ry., the Chicago, Burlington & Quincy R. R., and other roads are constructing such buildings, and consider them as being in line with good practice. A number of letters have been received, giving the experience and opinions of members, in connection with this subject and we would recommend that they be published as a part of this report in order that the association receive the benefit of all that has been offered in connection therewith.

EXTRACTS FROM LETTERS.

C. F. Loweth, C. M. & St. P. Ry.:—We have very few buildings of this character on our system, and it is seldom that this form of construction is considered advisable. When lumber was cheap a brick veneer building cost much less than one with solid brick walls, but now that the price of lumber is very much higher there is not enough difference in cost to justify the former. The brick veneer building has practically two walls, the outer of brick and the inner of frame, thus making the structure less stable than one built entirely of brick or of wood, and the fireproof qualities are only slightly better than of a frame building.

J. H. Markley, Toledo, Peoria & Western Ry.:—We have four brick veneered station buildings and we like them so well that we are going to build another this season. Two of these cost $10,000 each. They are located at Sheldon and Watseka, Ill. Another costing $6,000 is located at Washington, Ill.

To tie the brick and the frame we use a wall tie made of galvanized iron. These are placed opposite each stud at every fifth course of brick.

J. A. Landstrand, C. M. & St. P. Ry.:—We have built station buildings with brick veneer to a limited extent, and so far as their stability is concerned we have found them satisfactory. This class of construction is not considered favorable, however, because there is little or no difference between the cost of a brick veneer building and one built with solid walls. The disadvantages in brick veneer buildings are the greater fire risk, and the fact that the cost of construction is not materially cheapened. On the other hand, there might be localities where such construction would be advantageous, on account of the lighter load on the foundation.

J. Rivett, C. B. & Q. R. R.:—About 12 years ago we built a passenger station at Plattsmouth, Nebr., which was veneered with four inches of pressed brick. This building is on a concrete foundation, and the platforms are of brick laid flat. This building stands within 18 ft. of the main line where there is heavy freight traffic and today the brick work is in good condition. After this experience we feel justified in constructing other buildings of a like character. Until the present year this was the only station of the kind on the lines west of the Missouri River.

We are now building veneered station buildings at Walthill, Alma and Harvard, Nebr., the two last named being for passenger use only, and the first named for both passenger and freight. These stations will have concrete foundations; the studs will be 2x6 in., sheathed on the outside with 1 in. boards. The brick will be laid against the sheathing and in every fourth course we drive a 16-d wire nail into each stud for a wall tie, leaving the head of the nail extend about one inch into the mortar in the joint. The heads of these nails are flattened to avoid making a large joint. The space between the brick and the sheathing is filled with mortar for a height of five feet above the platform, on account of the liability of the walls being struck by trucks, barrels and other heavy freight, which is then much less liable to injury. Angle iron guards should be put on the corners for protection.

These stations are provided with tile floors, concrete window sills and angle iron lintels.

J. M. Brown, C. R. I. & P. Ry.:—I know of but one depot having brick veneer walls. This is a very neat station, built many years ago, and is still in good condition. At this time I do not think it advisable to build frame buildings, and then veneer them with something else. Formerly when lumber was cheaper, it was advantageous to do this, but since the advance in the price of lumber and since hollow tile can be secured so cheaply, I would advise against the use of the veneer type of buildings.

M. E. Gumphrey,
J. D. Moen,
W. Beahan,
R. O. Elliott,
W. A. Conkling,
Committee.

DISCUSSION.

Mr. Penwell:—This is a live subject to me, for the reason that we are using tile roofs to some extent. They have given such good satisfaction that we want to continue using them. We are even putting them on frame buildings but they make such buildings look a little bit cheap. Sometimes we cannot get sufficient money to erect a good solid brick building, but with brick veneer we might be able to get the outward appearance of such, together with reasonable fire protection from without, especially with a tile roof. I would like to recommend some veneered buildings to our people if I thought they would stand. I have had no experience in that direction but I

am looking for information; I had this matter in mind before the question was proposed to the committee on subjects last year. I would like to be able to get the appearance of a brick building but with a reduced cost from that for solid walls, because solid brick is too expensive.

Mr. Killam:—Along the line of the Intercolonial Ry. we have quite a number, probably 25 or 30, of brick veneered buildings. They are not satisfactory, although they have been built quite a number of years. I do not think there have been any new ones of that kind built in the last twenty-five or thirty years. They are now built of either wood or solid brick. Our terminal stations are built of solid brick, upon concrete foundations. The veneered buildings have wooden sills and very often we have to tear the brick away around the bottom to repair the foundation and that makes them unsatisfactory. Considering the price of lumber and material of various kinds we think that we can construct a solid brick building very nearly as cheap as one of frame veneered with brick.

The President:—I would like to have Mr. Markley state if the buildings referred to in the report have stone or concrete foundations.

Mr. J. H. Markley:—One has a stone foundation and the others are of concrete.

Mr. O'Neill:—I have not had any experience with veneering railroad buildings. I have built veneered buildings as a contractor and they are still standing and giving good satisfaction as dwelling houses, but I would not feel that I could recommend that class of construction for public buildings. I do not like a lath and plaster wall for the interior of a building to be used as a waiting room or passenger station on railroads. Our plans have always specified ceiling on the inside; even if we build a solid brick wall we use ceiling for an interior finish. In such cases I think there would be no economy in veneering.

I think that a station could be built with a solid brick wall and plastered inside, for less money than to build a frame structure, veneer it on the outside and ceil it on the inside with suitable material for a waiting room and then finish it in oil and varnish.

J. H. Markley:—Three of our brick veneered stations were lathed and plastered. Upon the rough coat of plaster was applied a burlap. Of course that makes it rather expensive, but our people wanted it that way and they got what they wanted. A good heavy cotton unbleached muslin is fully as good as the burlap, and not

nearly so expensive. This will keep the plaster from cracking, and paint can be applied directly over it.

I am now building a station with brick veneer at Secor, Ill., which is to be ceiled with Beaver-board; this is a material composed principally of wood pulp. It is some cheaper than the dressed and matched ceiling that has been used for that purpose for so many years, and is only about half as expensive as the plastered wall and burlap. The Beaver-board that we use runs from 30 to 36 inches wide.

Mr. Scribner:—I was surprised a short time ago to see an article in a technical paper referring to the cost of brick veneered stations. It was written by a man in the brick business, who was prejudiced in favor of his own products. He stated that the cost of construction of several buildings that he had known of being constructed of brick veneer was only about from five to fifteen per cent below the cost of a solid brick building. I had an idea that there was a greater difference between the cost of the two. The Burlington road is at present constructing two stations of this type, of which I have inspection, one at Fulton, Ill., and the other at Knoxville, Ia. I find that the cost of these is very little more than one-half what it would be for solid brick construction. However, that is not quite a fair comparison, because the stations with the solid brick walls are provided with better finishings, both inside and outside, than are these brick veneered stations. The method of constructing our brick veneered stations is to place the brick about an inch from the outside sheathing, fastening it with a metal bond, either galvanized wire cloth or a corrugated or wrinkled bond made for the purpose.

Mr. J. H. Markley:—This station at Watseka, Ill., is at the junction of the Chicago & Eastern Illinois R. R. Perhaps my brother, A. S. Markley, will tell us what he thinks of it.

Mr. A. S. Markley:—A brick veneered wall is not nearly as good as a solid wall in my estimation. Since my brother has raised the question, I will tell you what he has reference to, concerning the Watseka station. Mr. Scribner states that the Burlington road is building their stations of this kind with the brick an inch from the sheathing. Even a slight jam against the outside is liable to jar the brick loose. If I were building a veneered building I would lay the brick as close to the sheathing as possible and put mortar between, joining the brick and the sheathing as tightly as possible so that in case the brick did get a jar it would not be so liable to become damaged. The wall should be solid, at least five feet above the foundation, because freight men are liable to slam goods against it.

Veneered walls will not withstand that kind of treatment. The conditions at Watseka are such that we have experienced little or no trouble. The contents of a shot-gun were at one time accidentally discharged into the veneering and knocked out eight or ten bricks which had to be replaced. When it comes to the upper part of the building—say from the window sills up—I think that brick veneering would answer the purpose very well. The lower walls have to be made sufficiently strong to withstand the knocks from baggage and express trucks, etc.

Mr. J. H. Markley:—In the building which we are now constructing we are filling the intermediate inch space with concrete to a height of five feet above the foundation. This will make a fairly rigid wall.

The President:—I doubt the wisdom of adopting brick veneer for station buildings. I believe the discussion has brought out the fact that the saving in cost is not sufficient to warrant their use for railroad buildings. The nearest I ever got to construction of this kind was in 1905, when I designed a small suburban station building which had a solid concrete wall to the height of the window sills; above the line of the window sills it consisted of two brick walls with a two inch air space between, the walls being tied together about every fifth course. That proved to be a very warm building and yet it was not expensive. It was put up by our own forces and I always thought that buildings of that kind would be about as cheap as any and would certainly be preferable to a wooden building veneered on the outside.

Mr. J. H. Markley:—My objection to a veneered wall is that it contains so much combustible material that there is a great liability of fire. The nearer we get to incombustible construction the less the liability of trouble from fires.

The President:—Gentlemen, this report has no definite recommendation. It is a summary of the experience of various persons in connection with that class of buildings. I think that we ought to accept the report as presented.

It was so decided and the subject discontinued.

SUBJECT No. 10.

ROOFS AND ROOF COVERINGS.

REPORT OF COMMITTEE.

The features on which this committee was asked to report are as follows:

First:—Recommend the types of roofing best suited for the different types of buildings.

(*a*) With special reference to kind and incline of roof.

(*b*) Size and location of buildings.

(*c*) Necessity for painting or coating at stated intervals and probability of this being done.

Second:—Fire retardant value.

Third:—Value of guarantees, especially when material is applied by others than the guarantor.

Types of roofing best suited for the different classes of buildings:

As a general proposition the roofings suitable for use on railroad structures may be divided into five classes:

1. Built-up roofs, surfaced with gravel, slag or similar material.
2. Built-up roofs, surfaced with tile or brick, set in plastic material or cement mortar.
3. Built-up roofs without gravel, slag or tile surface.
4. Prepared roofings, with either smooth, sanded, or pebbled surface.
5. Overlapping tile, slate or cement shingles. Wood shingles are manifestly unsuited for railroad structures because of the danger from sparks. Metals, other than copper or Monel metal, are unsuited, as it is practically impossible to protect them against corrosion. However, on account of the practically prohibitive cost of copper and Monel metal, the railroad companies have gone to the use of galvanized iron or tin, where a metal roof is desired. Galvanized iron, in this case, is preferable to tin, as it is easier and cheaper to lay, does not necessitate wood roof sheathing and has as long life as the quality of tin that is made now. Galvanized iron can be used without painting, but if painted will last much longer. Tin must be painted when it is put on or it will soon rust out. Galvanized iron should not be used on a roof with incline less than 6 in. to the foot, while tin can be used on a roof with any incline.

1. BUILT-UP ROOFS SURFACED WITH GRAVEL, SLAG OR SIMILAR MATERIAL.

The gravel- or slag-surfaced roof is at its best on the flatter inclines. It has been used successfully on inclines as steep as 6 in. to the foot, but should not be specified where the incline exceeds 2 in. to the foot, except in localities where the roofing contractors are generally familiar with applying the surface material on the incline in question, and with satisfactory results, or after definite arrangements have been made with the contractor who is to apply the roof.

Tarred felt and coal tar pitch in built-up roofs have demonstrated their value by long use. Poor roofs of this character, however, are not rare, but are directly traceable to one of three features: Either the material was not

coal tar pitch and coal tar saturated felt; or the materials were improperly applied; or there was not a sufficient quantity used.

The principal cause of failure of gravel roofs has been the use of an insufficient amount of pitch. The number of plies of felt count for but little except that as the number of plies increase the amount of pitch that it is practical to use also increases. This type of roofing is suitable for all classes of structures having roof inclines as mentioned above, and its economy is limited only by the permanency, the size and the location of the structure.

2. Built-up Roofs With Tile or Brick Set in Plastic Material or Cement Mortars.

The utility of a tile or brick surface depends largely on the purpose to which the roof is to be put other than in the keeping out of water, and, to a limited extent, on the character of the structure. The tile or brick surface increases the cost from four to five times, and protects the water-proofing course in such a manner that its life is practically the life of the structure, and they can not, therefore, be considered economical unless the roof surface is to be subjected to considerable traffic.

3. Built-up Roofs, Without Gravel, Slag or Tile Surface.

Where the roof incline is too steep to permit of gravel or slag, and the character of the structure requires a more permanent covering than will be provided by a single layer of prepared roofing, and the artistic features do not suggest overlapping tile or the slate, the desired result is best accomplished by using two or more thicknesses of prepared roofings. The surface layer may have a smooth or pebbled surface, but the under layer or layers must have a smooth surface. The common two- or three-ply tarred roofing or the rubber roofings are best suited for the under layer and the succeeding layer should be cemented to it with plastic pitch or asphalt.

4. Prepared Roofings, With Either Smooth or Sanded or Pebbled Surfaces.

These are, in theory, suited for all classes of structures, and all inclines, but they all have fundamental weaknesses which render them generally impracticable for the more or less permanent structures where the roof incline does not exceed 2 in. to the foot. The weaknesses referred to are as follows: Being laid in a single layer, a single defect will cause a leak; the narrow laps allow water to back underneath where wrinkles develop; exposed nails rust out, or when driven into cracks or unsound wood, work loose; the small amount of water-proofing, material, 40 to 70 lbs. per 100 sq. ft., as compared with a minimum of 150 in a built-up roof, and total absence of, or a limited use of, surfacing materials that are in no manner affected by the elements, and give protection to the water-proofing material.

A paragraph from the conclusions reported to the Maintenance of Way Association can well be quoted here: "Ready or prepared roofings are recommended for use on small, temporary, and other buildings, where the cost, considering maintenance of more expensive buildings, is not justified; for steep slopes, where a built-up coal tar roof can not be used, and for locations where the skilled labor necessary for a built-up roof is not available. The steeper the slope the greater their relative value and the wider their economical field. The heavier varieties are in general the more desirable, because of their chance for longer life and their greater fire-resisting value. In making selections, the reliability of the manufacturers, service tests, and the cost should be the governing factors."

5. Overlapping Tile, Slate or Cement Shingles.

These materials are suited only for inclines in excess of 6 in. to the foot. Tile is most expensive and is used only to produce desired artistic effects. Slate is also used for similar reasons, but is not as durable as tile, and here we might quote a paragraph from the report of the Maintenance of Way Association committee on roof coverings:

"Slate and tile of suitable quality, properly protected and fastened, can be recommended on roofs, with a pitch of 6 inches to the foot or over, when the expense is not the governing feature; and where they aid in producing the desired architectural effect, except where there is much chance of driving snow, when eight inches to the foot should be the flattest slope allowed. The use of cement shingles is largely in the experimental stage."

(*a*) Kind and Incline of Roof Decks:—The question of incline has been treated in preceding paragraphs. There are two general types of roof decks, combustible (wood) and incombustible (concrete or book tile), with wooden decks to be covered either with built-up or prepared roofing, the smoother the surface the better the results obtainable.

The roof boards should preferably be tongued and grooved, with close joints. Roughness or slight irregularities are not so objectionable where a built-up roof is to be used, because of the larger volume of material and greater elasticity in that type of roof, but the surface of the roof deck has an important bearing on the results, even of built-up roofs.

It is practicable to apply any of the built-up or prepared types of roofings to any fairly smooth wooden deck, except as the roof incline has a bearing on the built-up type. With decks of concrete or book tile, there must, on the steeper inclines, be provision for nailing, and this is usually provided for by wooden nailing strips when the deck itself can not be nailed into. The heavier the roof covering the more necessary is the nailing. With the built-up type, having a gravel or slag surface, nailing is necessary when the incline exceeds one inch to the foot, and such a surface over a built-up water-proofing course is impracticable where the incline exceeds six inches to the foot. Prepared roofings give relatively less satisfaction on incombustible roof decks of comparatively flat incline than on wooden decks.

(*b*) Size and Location of Building:—The smaller the building and the greater the distance from the base of operation, of the roofing contractor, the better is the relative value of the prepared roofings, as the same skilled labor is not necessary in their application and special tools or equipment are unnecessary. For instance, the extra cost per square for transportation of men and tools is a comparatively small item on large work, but on jobs of say five hundred to one thousand square feet, it would often be almost prohibitive.

(*c*) Adaptability for Proper Application by Railroad Men:—All of the prepared roofings can be applied by the labor usually available on railroads for such work. The built-up types, particularly those having a gravel, slag or tile surface, should be applied only by workmen experienced in the use of such materials, and such labor is not generally available outside of well-organized roofing crews.

(*d*) Necessity for Painting or Coating at Stated Intervals and Probability of this Being Done:—The tile surface provides a permanent covering, of approximately the same life as that of any structure, without maintenance of any kind. The gravel or slag surface, when properly applied, does not require attention or maintenance during practically the life of the roof. When the surface of pitch has practically all worn away, so that most of the gravel has become loose and leaks develop, the gravel should be removed and two plies of felt mopped on and then regraveled in the usual manner, at a considerable saving in cost over that of a new roof.

When leaks develop in a gravel surface prepared roof it is usually on account of the original coating wearing away to the extent that the bare felt is exposed. It then disintegrates rapidly and it is not considered practicable or economical to recoat such roofs.

Smooth-surface prepared roofings that require painting are objectionable, as it is often impracticable to do the work between the time when the need of it is noticed and the time when painting becomes useless.

A grit or pebble surface on prepared roofing permits of a larger amount of water-proofing material on the surface and to some extent protects it from erosion. It is rarely feasible to paint the entire surface of a prepared roofing with grit or pebble surface, although weak spots can be helped in this manner. With such roofing of good quality satisfactory results are usually

obtained, but there is no necessity for coating, and any general repairs to the entire surface is not economical.

(*e*) Fire Retardant Value:—The importance of the roof covering from the fire retardant point of view caused the National Board of Fire Underwriters to authorize a special investigation of the subject by the Underwriters' Laboratories, of Chicago, and a special appropriation was provided for the purpose. The complexity of the subject and the fact that the individuals or even associations can obtain little information of value from each of such tests as it is practicable for them to make at any expense that would seem warranted, is indicated by the fact that the laboratory investigations have cost upwards of ten thousand dollars, to date.

At present there are but three classes of roofings recognized by the National Board, namely: Incombustible, which includes tile, slate, brick and metal inflammable, including wooden shingles; while practically every other type of roofing from the best felt, pitch and gravel to the lightest prepared roofing is in the intermediate class. Early in the investigation, the fact was brought to light that there should be additional classes, and the classification adopted at the meeting of the National Fire Protection Association in New York, May last, provides for six classes.

The complete report is contained in the National Fire Protection Association Quarterly, issued from 87 Milk St., Boston, Mass. The following extracts from the report are of special interest in this connection, and show the thoroughness of the investigation.

EXTRACTS FROM REPORT OF COMMITTEE ON DEVICES AND MATERIALS ON PROPOSED STANDARD FOR ROOF COVERINGS AND TEST SPECIFICATIONS FOR THEIR CLASSIFICATION.

CLASS A.

To include roof coverings which afford a very high degree of fire protection to the roof structure; which are not readily flammable; which do not carry or communicate fire; which do not give off flammable vapors or gases in large volumes when exposed to high temperatures; which possess no flying brand hazard; which possess considerable blanketing influence upon fires within the building, and which are durable and require repairs or renewals only at very infrequent intervals.

Composition Roof Covering, with Brick Tile Surface, Composed of 1-inch Hard Burned Clay Tile, Laid in 1 Inch of Portland Cement Mortar.

Covering constructed in strict accordance with the specifications advocated by the committee on roofs and roofings, as published in the annual proceedings of 1908.

The covering consists of a layer of water-proofing, composed of five plies of tar-saturated felt embedded in coal tar pitch, and an incombustible wearing surface approximately 2 inches in thickness.

This roofing would come under Class A when applied to both combustible and non-combustible roof decks on inclines not exceeding 1 inch to the foot.

CLASS B.

To include roof coverings which afford a high degree of fire protection to the roof structure; which are not readily flammable; which do not carry or communicate fire; which possess little or no flying brand hazard; which possess considerable blanketing influence upon fires within the buildings; and which are durable and do not require frequent repairs or renewals.

Composition Roof Covering with Gravel Surface.

Constructed in accordance with specifications advocated by the abovementioned committee.

The covering is composed of five plies of saturated felt, embedded and coated with coal tar pitch, into which the surfacing gravel is laid. This covering would probably come under Class B when applied either to fireproof or combustible roof decks, and where applied at inclines not exceeding 3 inches to the foot.

Note:—It should be explained that the specification for this particular type of roof covering nominates the best possible practice in the construction of a so-called tar and gravel roof. The specifications for the felt and pitch are rigid, and call for the use of a large quantity of pitch and gravel. Coverings which depart from this specification by reducing the quantity of gravel on the surface and the quality of felt and pitch, will undoubtedly take a lower classification. In fact, many of these coverings are liable to aid in the spread of fire over their surfaces, and after being subjected to the weather for several years will afford but little protection to the roof deck. The limitation relative to the height of incline is considered to be the maximum allowable height. It may develop from the field examination that it will be necessary to decrease this limit.

Tin Roofing—Flat Seams.

Covering constructed and materials used in strict accordance with the specifications advocated by the aforementioned committee.

This covering will probably fall in Class B for all inclines.

Note:—It should be particularly emphasized that the covering differs materially from tin roof coverings, as usually laid. The specifications call for the application of a 16-pound asbestos sheet, in addition to the ordinary roofing felt. This very materially adds to the fire resisting properties of the covering. The specifications also provide for a special form of seam, 5/8 inch wide, and a thorough means of nailing, which is very important in its influence on the life and behavior of the covering under fire exposure.

CLASS C.

To include roof coverings which afford a moderate degree of fire protection to the roof structure; which are not readily flammable; which do not carry or comunicate fire; which possess little or no flying brand hazard; which possess moderate blanketing influence to fires within the building; and which are durable, but which require renewals at fairly infrequent intervals.

Prepared Roofing—Asbestos Felt.

This covering is prepared ready to lay and can be applied to either combustible or non-combustible decks. It will fall in Class B, where applied to incombustible roof decks, and possibly in Class C when applied to combustible decks.

It is claimed that this covering is suitable for application to practically any incline, and if field experience proves this to be the case, it would probably take the indicated classification for all inclines.

Note:—As a word of explanation, it should be said that there are a considerable number of prepared asbestos roofings, and also so-called built-up asbestos roofings, on the market. The classification given here covers only a specific type of the prepared roofing, which is made up of plies of asbestos felt paper cemented together with an asphaltic cement. It must not be understood that the classification indicated would cover other asbestos roofings.

CLASS D.

To include roof coverings which afford a slight degree of fire protection to the roof structure; which are not readily flammable; which do not readily carry or communicate fire; which possess a moderate flying brand hazard;

which possess little blanketing influence upon fires within the building, and which require repairs or renewals at fairly frequent intervals.

Natural Slate—Laid Shingle Fashion.

Covering composed of slate 9x18 inches, laid 7½ inches to the weather over sheathing paper, and held by two nails. This covering would probably fall in Class D, where applied to inclines not less than 6 inches to the foot.

Note:—The quality of slate varies so widely that it would not be fair to say that all slate is entitled to this rating. It is probable that some types of slate might be entitled to a classification as high as Class C.

CLASS E.

To include roof coverings which afford little or no fire protection to the roof structure; which are not readily flammable; which do not readily carry or communicate fire; which possess a moderate flying brand hazard; which possess little or no blanketing influence upon fires within buildings and which may require repairs or renewals at fairly frequent intervals.

Prepared Wool Felt—Stone Surface.

Roof coverings of this general class, made of the best quality of materials and thoroughly covered with a layer of incombustible material, should qualify for Class D.

It is at present known that many of the so-called stone surface prepared roofings will not classify even as high as Class E. On the other hand, it is felt that there are many coverings which will take the classification indicated.

CLASS F.

To include roof coverings which afford little or no fire protection to the roof structure; which are readily flammable; which will rapidly carry and communicate fire; which possess more or less severe brand hazard; which possess little or no blanketing influence to fires within the building; and which may require repairs or renewals at fairly frequent intervals.

Prepared Smooth Surface Roofings.

It is believed that many of the prepared smooth surface roof coverings will qualify for Class E, and possibly some of them may possess sufficient value to classify under D. It is known, however, that some of them will fall in Class F.

The committee particularly wishes to emphasize the hazard attached to the use of wooden shingles. Wooden shingle roofs are a menace to property, and have repeatedly demonstrated their hazardous nature as conflagration breeders. Their use is prohibited by law in many localities. It should also be noted that, as compared with roof coverings possessing fire retardant properties, wooden shingle roofs now require repairs and renewals at fairly frequent intervals.

GUARANTEES.

Guarantees have become more of a factor in roofing than in any other work connected with building construction and are frequently put in the foreground, so that the real point at issue, the merit of the roofing, will be overlooked. They should, therefore, be subjected to the closest scrutiny. Very naturally guarantees for five years or ten years will appear in the light of a safeguard, but they are not given because of the sublime faith the guarantor has in his roofing or because of any generous impulse on his part, to protect the buyer, but for one purpose only—to sell the roofings. For the purpose of considering their value, they may be divided into three classes:

First: Where the guarantor is responsible, and gives the guarantee in good faith. In such cases the buyer has the assurance that the roof will be repaired if it leaks, but there is not any protection against damage, as a guarantee against damage would be a greater liability than any solvent contractor would assume, even with the best of roofs. No matter how often leaks occur, all the owner can require is that repairs be made with reasonable promptness, and, as frequently happens, it is better to buy a new roof than to stand the loss and inconvenience caused by leaks.

Second: When the guarantor is responsible, but purposely words the guarantee to mislead, and avoid legal responsibility. This class is the most misleading and causes the greatest loss. It embraces the "painting every so often" clause, usually calling for material which the owner must buy and apply at certain specified times. One day over, and the guarantee is in doubt. This means a division of responsibility, and there are literally dozens of excuses why the manufacturer is not to blame; and then include many that are fair, as roofing is frequently used on a roof incline for which it is entirely unsuited.

Third: Where the guarantor does not remain in business or remain solvent for the term of guarantee. A surprisingly large percentage of firms remain in business less than five years, to say nothing of ten years, and this is no more true of any class than of roofing contractors.

Tile, slate, copper and shingle roofs are rarely guaranteed for more than one year, if at all, so they need not be considered, but it is the two classes, "prepared roofing" and "built-up gravel or slag roofs" that have been and are most affected by long time guarantees.

In buying prepared roofing the character of the building, the incline of the roof, the chances of the roof being recoated when needed (if roofing is used that requires such care), the length of service the roof is expected to give, the experience of others with the same material used under the same conditions for as long a time as it is claimed it will last (printed testimonials should not be accepted without careful investigation), and the reputation of the manufacturer for fair dealing; that is, his practice of making good without written guarantees is a factor of far greater importance than any guarantees. When, with built-up gravel or slag roofs it was the general custom to consider the quality of material, amount of material (that is, the number of plies and weight of felt, and pounds of pitch), knowledge regarding the use of the materials and records of roofs in service, it was usual to have gravel roofs last longer than they do today; but since the ten-year guarantee was made the basis for price, and contracts awarded to the lowest bidder, most of the responsible roofing contractors have had no option except to figure on a ten-year roof, and if the contract was awarded that is all they could give, as it was all they were paid for or agreed to give. Generally, a roof which requires no repairs for ten years will give service for a much longer time, but naturally roofs that require repairs during the term of guarantee are of little value at its expiration.

In conclusion, our recommendations are that all structures with a roof incline of less than two inches to the foot be covered with a built-up gravel or slag roof, constructed under a specification, definite especially as regards amount of materials, and that there be competent inspectors to see that the specifications are fulfilled; that prepared roofings be used on temporary structures and those of minor importance and all steeper inclines, except where architectural features demand tile or slate, and that preference be given to the smooth surfaced roofings where there is a certainty of recoating when needed, and to grit or pebble surfaced roofings when such care will not be necessary; that prepared roofings be applied by railroad men, that where painting or coating is necessary there be a system that will insure a thorough inspection and report on the condition of the roof at least once in six months and that from the fire retardant point of view, roofings be selected in the following order:

Tile, gravel or crushed stone or slag, metal, asbestos, slate, pebble surface prepared; grit surface prepared; smooth surface prepared.

T. J. Fullem,
G. W. Andrews,
Committee.

DISCUSSION.

The President:—The assistant secretary will now read the report of the committee on subject No. 10, Roofs and Roof Coverings.

(Mr. Jutton read the report.)

The President:—Before opening the discussion, I want to say that we have with us tonight a gentleman who has given the matter of roofs and roof coverings considerable study in connection with his investigations for the American Railway Engineering Association, and he has promised to give us a talk on the same subject. I want to introduce to you Mr. Maurice Coburn, principal assistant engineer of the Vandalia R. R.

Mr. Coburn:—I did not understand that I was going to open this discussion. We have had a very interesting time, investigating the roofing question. The subject committee of which I was formerly chairman, took it up because the choice was left to me and I selected roofing because I knew absolutely nothing about it and wanted to learn something.

The main thing we have tried to do has been to get some knowledge of the bituminous roofing materials and their relative qualities. The industry is a large and growing one, but it is a new one, and almost all of the definite and accurate information has been in the hands of the manufacturers, so that when we tried to get some idea of the comparative value of these materials we found it was a difficult matter. Most of you know how we have all suffered from the roofing salesman who has been sent out without any information which he could give us which was of value. He did not know himself, and we can not blame him for not telling us anything. The manufactureres themselves often did not know so very much about it, and what they did know they kept to themselves. We have all been told that these various roofings were made of a wonderful secret compound which they have developed after many years of experience and which it would not do for us to know anything about.

In the built-up roofings, most of us think that we have the best type of a bituminous roof, because there we can get all the material we want. With a ready roofing, the amount that can be put into a roll is very much limited.

For the built-up roofings the question arises as to a choice be-

tween a coal tar roof and an asphalt roof. Our committee last year recommended a built-up coal tar roof, for several reasons. The asphalt roof has some very decided advantages. The coal tar melts readily and gets brittle very easily. In the summer time it is soft and runs, and in the winter time it is brittle and cracks; but it is easy of application and it is cheaper than the asphalt material, both as to the first cost of the material and the cost of application. We can control the flowing of the pitch and we can lay it so it gives good results. We all know that we have had many good roofs which have lasted as long as anybody could expect a roof to last, and often as long as we want it to last.

The asphalt material is an uncertain quantity; it is a mixture of several different materials. In buying it one must depend entirely on the word of the man selling it, and in laying it requires more skill in its application than a coal tar roof.

I think that almost everybody agrees that we get more for our money out of the coal tar roof. When the asphalt man comes in to see you he will tell you, nine times out of ten, that the coal tar we get nowadays is not as good as it used to be. We do not think that is so. There have been a great many failures of coal tar roofs during the past few years, but notwithstanding the fact that the coal tar industry is largely in the hands of a single concern, we think we are able to get good roofing material and we feel that this concern is trying to improve the quality of their material. When it comes to asphalt, it is made by a great many different people and it is a great deal more difficult to get accurate results.

The water-gas tar question is by no means a closed one, but I believe that practically all agree that the small percentage of free carbon contained makes its pitch a poor top coating, and the most practical roofing men seem to agree that its products, used either as saturants or coatings, are not as stable as those made from coal tar.

When it comes to ready roofing, coal tar is not at all a fit material, in our opinion. Coal tar is valuable only when it is in a thick layer. If we take a piece of coal tar felt and put it up with a piece of asphalt felt, the coal tar felt will get brittle much quicker than the asphalt felt. Almost always, when the coal tar weathers there is a little hard scale of free carbon or other hard material on the surface, which, in a measure, protects the rest of it. The inner parts stay soft and keep their life, if it is good material. One of the troubles with coal tar roofs has been that so many have been built out of poor coal tar or built poorly.

In the ready roofings, there is, in our opinion, almost no virtue

in a single asphalt fluxed with an oil. One must get a mixture of several different asphalts to obtain a satisfactory substance, and when they come around and tell you that they have got a Gilsonite roof fluxed with oil or a Trinidad roof fluxed with oil, it is surely a poor roof, if they are telling you the truth. The best results are obtained by mixing three or four different things. Some of our good friends think that Trinidad is good for roofing and some think it is very questionable whether it is essential to good roofing. It has been much advertised. Gilsonite, the western asphalt, has certain virtues, but mixed with oil alone it is a poor stuff, because the oil dries out. The California oil residuals have certain virtues and petroleum residual oils, blown or treated with air have certain other valuable qualities. They are not easily affected by changes in temperature and the atmosphere does not seem to have much action on them. Elaterite, a western asphalt which, in some ways, resembles Gilsonite, furnishes a product which is used in some of the best ready roofings and sells for a high price; and by mixing some of these different products and fluxing with some oil, we can get a very fine mixture; but when it comes to using it and having it applied by unskilled people, owing to the heat necessary and the ease with which it cools, we are not sure of getting such good results especially in cold weather on a built-up roof. But, for a ready roofing, something of that sort seems to be what gives good results. Some of the mixtures are fine and some poor. We cannot tell by any analysis or any knowledge of the material beforehand unless we know how it is mixed, and we do not know how that is done; only the skilled man knows that.

The quality of the felt does not make so very much difference. We are told about all-wool felt, but we feel like the farmer who went to the circus and saw the giraffe for the first time—" There ain't no such animal."

Every few weeks our committee learns something new, and we change our opinion to some extent. I learned something last week which materially affected some things I thought I knew very thoroughly and I have now been on the subject two years and a half. You should take all I tell you with a grain of salt, and if you have any information with which to correct us in our reports, we would like to have it. (Applause.)

The President:—We all feel very grateful to Mr. Coburn for the talk that he has given us and I feel that he gave us a great deal of information on the subject. We will now discuss the report as it has been read. We would like to hear the members express them-

selves quite freely on the subject as it is a very important one. Mr. Fullem is not here, and I will therefore call upon Mr. Andrews who is the next member on the committee. Will you kindly give us your views, Mr. Andrews?

Mr. G. W. Andrews:—I have very little to say in addition to what is incorporated in the report. It is true that this committee, I think, labored under the same difficulties that the committee of the American Railway Engineering Association labored under. I will say that, because I was on the same committee with Mr. Coburn and I can vouch for the truth of the statements that he has made relative to the difficulty that we have experienced in getting information from the sales agents and from the manufacturers of the various kinds of ready prepared roofing. I will say this, though, in justice to the sales agents, that I believe they have always given me all the information that they had. As a rule, however, their information was based simply upon what they had been told by the manufacturers, concerning the quality of material, and, of course, they were trying to sell as much as possible. I always like to see them come into my office, because when they go out they almost invariably say that, while they have tried to sell material, they have not been able to get me to say anything to them. The information given in the report states the views of the committee, I think, very clearly, and in the absence of Mr. Fullem I would be very glad, if possible, to explain any discrepancies that some of our members may feel are incorporated in the report.

A Member:—I would like to ask Mr. Andrews why the committee considers tiled roofing more durable than slate.

Mr. Andrews:—I don't know, Mr. President; I cannot recall whether the report states that or not. If it does, it does not fully express my views. Personally, I think that slate is preferable to tile.

Mr. A. S. Markley:—Can I get the sense of the report in reference to book tile? As I understood the reading of it, it would be necessary to put on wood to nail the felt to. Perhaps I don't understand it thoroughly. That is different from the way we have been using it.

(Mr. Andrews re-read a portion of the report.)

Mr. A. S. Markley:—In putting on roofing of book tile, we have always applied the tar and then laid the felt in it. I do not believe that it is hardly necessary, in a case of that kind, to use nailing strips. Tar, properly tempered, will hold, on a roof quite steep. The roof I refer to was put on in 1904. It has a pitch of one and a half inches to the foot, and since then there have been no repairs

and no leaks whatever. We used Barrett's preparations in the make-up of the tar. Furthermore, in reference to built-up roofs—in 1884 we put a roof on our freight house in Chicago at 12th Street, with our own bridge carpenters, and, of course, we were liberal with the tar, realizing that it was an important roof and we wanted to keep all the dampness or water out that was possible. We have recoated that roof but once since 1884, and that is the reason why we favor a built-up roof in almost every case. Wherever a building can be built with a view of using that character of roof, it should be done. I would like to hear from some other member. Mr. Horning, you have quite a lot of information and experience about roofs of all kinds.

Mr. Horning:—We have roofs of nearly all descriptions. In the question of a roof however the particular design of a building usually governs the particular kind of roof to apply. There can be very little question about the reasons for applying a tile roof equally so with slate. The design of a building, in nearly every case, will distinguish plainly between the two. We use tile for some stations and have received very good results. Also we use slate for a portion of our more expensive buildings with reasonable success. The prepared roofing that we used has given moderate satisfaction. We use it on small buildings especially and on buildings in out of the way places where other roofs cannot readily be had, but in no case do we use them on passenger stations where appearances are to be considered.

The question of roofs is a live subject and it would seem to me at this time that the problems relating to it have not been exactly solved. It is a question that should be continued next year because nearly every member here has, no doubt, had more or less trouble.

Mr. C. J. Scribner:—The roofing men seem fairly well represented in the lobby and I presume we could get some information on this subject from them. I would suggest that we invite them in.

The President:—I do not suppose there would be any particular objection, with the understanding that no particular brand of roofing should be advocated. In other words, it should not be made an advertising scheme. We would be very glad to have the roofing men state their views of the matter, without advocating any particular brand.

Mr. H. A. Wardell:—The question has been brought up as to the relative merits of asphalt and coal tar pitch. Before going into the subject I wish to refer to Mr. Coburn's statement relative to the roofing salesmen being something of a nuisance. I believe that, to

a certain extent, he is correct, but we have all first to learn, and every young man who takes a position as a roofing salesman goes out with the information that is given him by his superior officers. He may get it all or he may get a smattering of it, but he does his best, and in doing it he is trying to make an honest living. Sometimes, like a fly, he tracks good things into the offices of you gentlemen, as well as being a "nuisance" by tracking in things which are not interesting.

Mr. Coburn very correctly states that coal tar pitch makes an excellent roof. He who says it does not, does not know the roofing business. Experts in the roofing line state, however, that it is good only on flat surfaces or those with a pitch not in excess of two inches to the foot. Expert tar people also very strongly advise the use of "enough" pitch, and claim that failure is due to improper application and insufficient material. They also advise very strongly against "improper materials." Those who have to do with manufacturing pitch from water gas claim it to be equal to pitch made when making gas or coke from bituminous coal. Those who control the pitch of this country, made from bituminous coal, say pitch resulting from the manufacturing of water gas is not good. Who is right? And if this is a fact, is it not a fact that it is just as difficult to get good tar pitch as it is to get good asphalt? I do not pretend to say gas pitch is no good. If I did you would all know that I do not know what I am talking about. But I do say that pitch, both practically and theoretically, is not as good as good asphalt, and I think I can prove it. Furthermore, I claim it is just as difficult to get good tar pitch as good asphalt. The asphalt industry is in the hands of few people and the coal tar industry is in the hands of fewer people. Nevertheless, both good asphalt and good coal tar pitch may be had; it depends entirely upon the purchaser.

Mr. Coburn has said he believes that perhaps water gas tar is a little more worthy of consideration than a year ago. Is it really any different than it ever was—and what is coal tar and what is water gas tar? Coal tar is the result of breaking down bituminous coal in either a gas retort or a new process coke oven. Water gas tar results from making gas by the water process. Both contain valuable constituent parts, especially the tar made from bituminous coal—parts worth double the price of pitch—and there is a shortage of creosote oil, one of the parts derived from the separation of the bituminous tar, the so-called best tar. There are, however, certain lighter oils that are not so valuable and they come off before the creosote oils, and are used to make what is known as "cut back"

pitch; and "cut back" pitch is very difficult to distinguish outside of the laboratory, from straight run pitch. Bituminous coal tar pitch also contains 20 to 30 per cent of free carbon or soot, an inert material, which, according to coal tar people, is necessary "to give it body."

I don't want to throw any bricks at coal tar, because it has given excellent service, and a good coal tar roof can be constructed today with honest workmen and honest materials, but I want to say that it is just as difficult to get honest workmen and honest materials with coal tar pitch as with asphalt, Mr. Coburn to the contrary notwithstanding.

Asphalt comes from many parts of the world and nearly every asphalt has different characteristics; Grahamite, from Indian Territory, West Virginia, Cuba, Colorado and other small deposits; Gilsonite from Utah, and asphalt, resembling Gilsonite very closely, from Cuba and Egypt; lake asphalt, from Trinidad, Bermudez and Maracaibo and many others. Elaterite, referred to in the report as being an asphalt, is not asphalt in the true sense of the word and is not generally used for roofing. It is a hybrid—a peculiar material not readily soluble in the usual solvents and can not be used in connection with flux oils by heating. It is broken down in a retort by the exclusion of oxygen. It has valuable characteristics after it is broken down in connection with other asphalts.

Trinidad Lake asphalt comes from Trinidad, B. W. I., and has probably been used to a greater extent for street paving and other purposes than any other asphalt. Why? Because it has universally proved to be the best asphalt ever discovered. Asphalt is better than coal tar, because it is longer lived; because it contains the necessary non-fugitive oils to keep it alive, which is not the case with coal tar. To prove this, let us consider a street pavement. A pavement is composed of 90 per cent mineral, in the shape of silicate (sand, if you please) and limestone or other mineral dust, and these granules of sand and dust are cemented together with asphalt; and just so long as the asphalt has the ability to cement those particles of mineral together, just so long will the street live and not a day afterward. This, therefore, proves that asphalt, even Gilsonite, has cementing characteristics for a greater length of time than coal tar pitch. Primarily, coal tar pitch is just as good as asphalt, but coal tar or coal tar pitch do not contain the necessary non-volatile everlasting oils that are necessary for a durable lasting waterproof cement, and asphalt does. To prove this coal tar roofing pitch and Trinidad Lake asphalt roofing cement can be submitted to the usual

laboratory test for stability. The test is to subject the materials to 325° F. for seven hours. Asphalt cement will lose less than 8 per cent, the residue being soft and plastic, while coal tar pitch will lose 15 to 20 per cent, the residue being very hard, glass-like and lifeless.

What does this all prove? A roof depends on the cement holding the plies of felt securely together, indefinitely, as the cement holds together the sand in an asphalt street, and the laboratory test shows conclusively that the necessary oils to keep it alive and plastic and able to maintain the cement in action are very much more stable in asphalt than in coal tar pitch.

There are concerns manufacturing asphalt in the United States with good reputation, people who brand their materials; people who have the ability to properly combine asphalt mixtures; so you can get asphalt roofing cement which is and will remain plastic practically forever. Perhaps you might think that this statement cannot be borne out by facts, nevertheless there is a little story that makes everybody smile, but it is a true one. It is a well-known fact that mummies have been disinterred, showing that the body had been wrapped in a cloth saturated with asphalt, where the asphalt has been found to still have life. I know where coal tar pitch has been brought out of the ground in New York City, full of life after many years, thus showing that both of these materials will live, if they are not subjected to the influences of sunlight and the atmosphere, indefinitely, but in a street or on a roof it is quite another matter. I make this statement so as to be absolutely fair, but I do not believe it can be shown that coal tar pitch is better than asphalt, or that there is any more difficulty in obtaining good asphalt than good pitch. Coal tar pitch, it is admitted, depends for its life on being coated or covered, if you please, with some material such as slag or gravel, which has the effect of making it immune to the deadly action of the rays of the sun. Asphalt is just as susceptible to these influences as coal tar pitch. Thus an asphalt-coated roof needs slag or gravel or some other covering just as much as coal tar pitch, but coal tar pitch, as before explained, will dry out and disintegrate much faster than asphalt.

Coal tar pitch has one characteristic that asphalt has not. It contains a small amount of creosote, which is a fungicide and which prevents the wool felt from rotting. I admit that wool felt saturated and not coated with asphalt will rot if kept wet, but it will not dry out and be as lifeless as a chip. I claim that several layers of asphalt felt properly protected from underneath moisture, will give a good and lasting account of itself.

There are good and reliable manufacturers of asphalt felts and asphalt cement, who have been making these materials for twenty-five years. They use Trinidad asphalt and they stand by it today and have a good right to do so, because the materials are good. Mr. Coburn, or any of you gentlemen, can get a certain brand of asphalt and know that it will be good stuff, and there are a number of other brands on the market just as good.

If you gentlemen will look into this asphalt question, you will find that it is being used by high-class, reputable concerns; concerns that are honest in their endeavor to turn out a roofing which, perhaps, is not perfect, but is at least sincerely made; and I claim to represent one of these concerns, but I am not here to advertise any brand. I want to say that if asphalt will live for twenty-five years in a street, holding together a mineral aggregate of sand, (Theressa Ave., in this city, for instance), why then is it not the best cement to hold together the waterproofing on a roof? On a roof it does not have to contend with conditions which exist in a street; such as attrition, acids and innumerable other things. Therefore I claim again that it has much greater life and endurance than coal tar pitch. If it was not better than coal tar pitch why is the latter not used for paving, and by the manufacturers of the so-called rubber roofing, including the largest coal tar people who make the rubber type of roofing? You must admit that in this class of roofing material no very great quantity of asphalt is used per square foot, as compared with coal tar built-up roof. Why should we use 7,500 tons of asphalt per year in the manufacture of roofing materials if we did not know which is best. We do not mine asphalt—we refine it. We do not produce coal tar pitch. We have absolutely no interest in either beyond the fact of getting the best possible material. Why, then, should we spend $15 more per ton for asphalt if coal tar pitch is as good? Our reputation and our success is dependent upon the longevity of our roofing and its ability to keep out water.

I might dwell upon the manufacture of felts, on the residual asphalts that are produced by distilling Texas and California oil, and on many interesting phenomena occurring in manipulating asphalts in coal tar pitches. I could tell you of the asbestos fibre and why it makes a wonderful fireproof, weatherproof, sunproof, waterproof roofing fabric. How it makes capillary attraction (the death-dealing agent of all volatile substances) impossible, and tell you of the really great progress that has been made with roofing materials, but I am only asked to discuss the question of merit be-

tween asphalt and tar pitch. I am obliged to you for your attention.

Mr. O'Neill:—I have listened to a great many talks from agents who represent the roof manufacturers, and this is the first agent who ever left me after a good talk without offering me a cigar. Now the gentleman has given us a good talk. I want to say that he seems to be better posted on the goods that he is handling than any man that I have ever talked with on the question, who represented roofing, and I was pleased to listen to his talk, but was a little sorry, of course, that he didn't hand out the cigar.

Now I want to touch on the question of the wooden cleats on book tile. I don't just understand, myself, how they could be put on, how they could be fastened there without being rather expensive. Of course book tile is laid on angle plates, and they could be drilled and the wooden strips fastened, but it would be an expensive method. Six years ago this summer, I built up a roof of book tile with a pitch of four inches to the foot, and it has never given any trouble. It is apparently in good condition today, and all that fastens it in the book tile is a good coating of hot coal tar pitch and the paper rolled into it as a beginning, each successive layer rolled in coal tar pitch and applied to the next layer below. I can not see the necessity of any wooden strips or nailing in order to fasten a built-up roof on book tile.

Mr. J. H. Markley:—I do not want to be accused of being ungrateful to the committee, but in our practice of recoating built-up roofs, we, in all cases, take off all the gravel we can, recoat it and put the gravel on again. I have never known of any paper or felt put on the roof in the recoating process. One cannot get all the gravel off, of course, and there are pebbles that stick up so that it would be difficult to make the felt adhere unless enough tar was used to bring it up above all the pebbles so as to make a smooth surface. We have a roof that I spoke of awhile ago, on which we used that method. We swept all the dirt off and took off all the loose gravel. What stuck to the roof we left on. I notice that the report says to put the paper on over the gravel in recoating.

Mr. L. P. Sibley:—I am perhaps more interested in coal tar products than asphalt, and I have a few words to say in reply to the statement that Mr. Wardell made. Before doing so, I would like to reply to the last speaker, in regard to the resurfacing of a gravel roof; that is, by scraping off the gravel and putting on additional plies of felt. That is practical only when the pitch on the surface has largely worn off and the gravel become loose. Most of

the gravel can then be swept off and what is still imbedded in the pitch can be scratched off with scratching bars, so as to provide a surface sufficiently smooth to lay additional plies of felt; and while that is not economy ordinarily, there are frequently buildings that for various reasons may not warrant the cost of a new roof, but would warrant the cost of two plies of felt and regraveling.

In regard to the placing of nailing strips in book tile, I agree with the criticism that it is hardly practicable. It is, however, practicable to bed the nailing strips in concrete as the concrete is being made. It is a fact that the built-up type of roofing is applied on inclines exceeding an inch to the foot without nailing, and applied successfully, but the factor of safety is not large, and there have been numerous instances where such roofs have slid or slipped for lack of proper nailing. I think the general opinion is that where the incline exceeds one inch to the foot, nailing of some kind is desirable.

As regards the illustration made use of by Mr. Wardell, that because asphalt is best for paving it must be best for roofing: The fact has been brought out that paving, 90 per cent of the pavement is a mineral, that is, silica or sand, while only approximately 10 per cent is a bituminous material or asphalt. It is an acknowledged fact that asphalt is less easily affected by heat and cold than coal tar pitch, and a pavement that will not become soft in summer or brittle in winter, is a very necessary factor. Pavements are all subjected to considerable traffic that keeps them compacted during warm weather, and I think it is quite generally recognized that with a street having a fair traffic the pavement on it will last much better and is far less liable to crack than on a street with comparatively little traffic. A roof does not have such traffic, and on a roof the asphalt is used clear, not mixed with 90 per cent of sand. A roof must resist water, not traffic.

The statement has been made that the life of coal tar pitch is dependent on the oil in that pitch, and that it can be easily shown by accelerated tests (accelerated test, not field experience tests), with a temperature of 325 degrees, that the life of the coal tar material is much less than that of asphalt. There is a very good reason why those tests show a higher evaporative loss on coal tar materials than on asphalt materials, because the coal tar materials, being more easily affected by heat, become more liquid at that temperature than the asphalt materials do.

Nothing has been said about the oils that are required for the fluxing of asphalt. The Trinidad asphalt mentioned, that is more

successfully used in paving and more generally used in roofing than any other kind, requires upwards of 30 per cent of flux of some kind before it can be used even as a roofing cement, and when one talks of saturating felt with pure Trinidad asphalt, it is asphalt only in name, because Trinidad asphalt is naturally a solid. It requires upwards of 75 per cent of oil flux before natural asphalt can be used to saturate felt, but it is still called asphalt, even with 75 per cent flux; and as the asphalt used in preserving mummies has remained uninjured for centuries, asphalt is, of course, good for roofing. Coal tar pitch was not used to preserve mummies, but it is the waterproofing agent in more than 95 per cent of all the gravel or slag roofs in America, even though asphalt, with all its wonderful properties and unlimited supply, has been actively promoted for more than thirty-five years. Good roofs have been constructed with asphalt, the same as with coal tar pitch, but it is coal tar pitch that gives the best value. Results prove it and the figures show that the general public learned this fact long ago.

As your report has stated, the principal reason for the poor so-called tar-and-gravel roofs, is the use of an insufficient amount of material, and as the report of the American Railway Engineering Association committee on roofing, of which Mr. Coburn was chairman, stated, the good results from gravel roofing were undoubtedly due to the fact that a large volume of material was used in such roofs. The poor roofs have had perhaps the same number of plies of felt, but the number of plies of felt has very little relation to the value of a roof, except as the number of plies increases, the amount of pitch that it is practical to use also increases, and if one is to have good value for the felt used, there should be a complete mopping of pitch with each ply of felt, beginning with the second ply. When the roof deck is of boards, it is usually considered necessary that there should be two plies of felt under the first mopping of pitch, but with a concrete roof deck each ply of felt should be mopped solid.

The use of gravel or slag on the surface of the roof protects the waterproofing material from the direct rays of the sun and from the erosion or the wearing from the rain that flows over the roof, and it further permits the use of more than a paint coat on the surface, because the gravel or slag tends to hold the pitch in place. The same is true whether the pitch is a coal tar pitch or an asphalt pitch.

Mr. Coburn:—Regarding the statements that have been made, particularly by Mr. Wardell, I think I agree with more of them than might at first appear. Our committee, I believe, has fully agreed

that you can get just as good, if not a better roof from an asphalt pitch as from a coal tar pitch, but we do not think that in the long run, dollar for dollar, one can get as much value at the present time, from buying built-up asphalt roofs, as he can from coal tar roofs. I ought to say, also, that the roofing people are coming more and more to help us. I think that we are going to get together better, to understand each other better and understand the materials better. I also wish to say, that in my opinion, some of the things Mr. Wardell said in comparing the different materials are very misleading.

S. J. Waterman:—The old saw of "there's nothing like leather" in railroad parlance and practice, should be transformed into "there's nothing like metal." No other material so fully meets the requirements of railroad construction in its easy adaptibility, in its great variety of forms, to all the demands of buildings, bridges, etc., in its reasonable price, both for material and application, in the low cost of repair and replacement, and its durability in service. This is especially true of metal in the form of sheets for roofing purposes, and the protection of wooden bridges and trestles against fire and weather. In the most popular form of corrugated sheets it can be used for roofs on a metal frame or simple structure of wood sheeting and purlins, eliminating sheeting boards, which most forms of roofing demand; thus both reducing expense and rendering the structure proof against fire without or within. Where conditions make other forms preferable it can be furnished in plain sheets, black, painted or galvanized, "roll and cap roofing," "V crimp" metal shingles, "standing seam," etc. In these varied shapes its use is familiar to you all, and I think I am safe in saying that no other roofing has had so large a demand and made so honorable a record in your service. Many of you have personal knowledge of old metal roofs which, after a life of twenty years and upwards, have been removed because of alterations, improvements or like causes and found perfectly sound.

I read in a recent article in the Engineering News of timbers in trestles erected in 1879 and protected by galvanized iron sheets that were examined and found sound, only rotting where bolt holes, etc., had permitted the weather to affect the parts immediately exposed thereby. The sheets not only protected the bridge deck against fire, but preserved it better than ballast would have done.

Since the turn of the century, with the general adoption of steel sheets in place of iron (due both to lower cost and the better working qualities of the former), it has been found that metal does not

give as satisfactory service as of old, and I believe your organization is on record as discouraging the use of steel sheets for the above named purposes.

No one was more keenly alive to this vital defect in their product than some of the rolling mills themselves, and various methods were tried to improve roofing products, mainly along the line of coating sheets with different substances to prevent corrosion. But one mill, at least, recognized that the trouble lay deeper than the surface and has met it by a most thorough and scientific process of fabricating the metal itself so as to produce a pure iron sheet, anti-corrosive, and free from those elements which, in steel sheets, are the points of attack for moisture, sulphur and other gases. This article has stood up under the most drastic acid, salt and alkali tests, but more than all in the test of actual service, during the past five years, has it justified the claim that it has the staying qualities of the old Juniata iron sheets, no longer made. Its cost is much less than the price Juniata iron sheets used to bring, and little more than that of steel. Its long life in service renders it a most economical material, far outlasting steel sheets. While the greatest emphasis is placed on the base sheet, which determines the final durability of the roof or deck protection, the added safeguard of any desired coating of paint or galvanizing is furnished, when required, and it is marketed in all forms of roofing, as well as in the plain sheets. In no other field has this metal created such interest by good record as with the railroads, a considerable number of whom are specifying it largely in place of steel sheets for buildings, bridges, culverts and flumes.

Mr. Robinson:—The opinion was expressed here that composition roofing should not be used, or was not adapted for use, on passenger stations. The train shed of our old Wells St. terminal, in Chicago, was covered seven years ago with that style of roofing, and, while it was subjected to about as hard usage as any roof, it gave most excellent service. When that shed was torn down this year some of the composition roofing was removed elsewhere and applied to another building in order to see how much longer it would last. The structure from which it was removed had a pitch of only about two inches per foot.

Within the past year we had a new station built by contract with a roof made up of coal tar pitch and gravel, from which have resulted several claims for damages on account of the pitch dripping over the edges and soiling ladies' clothing.

We also had a building at the Chicago shops which had a coal tar pitch and gravel roof, the building having been used as a store-

house for patterns. Some of the boards shrunk, the felt opened up and some of the pitch ran through and damaged a lot of our valuable patterns. Other buildings were built near by in 1892 to 1894 which were covered with similar materials, and they gave most excellent satisfaction; these buildings have had the roofs repaired but once in the meantime.

Then, again, we put up a building about ten years ago, about 200 feet by 600 feet, which was covered with composition roofing, and that roof is still in excellent shape; hence it may be said that good roofs may be made of either of these two classes of roofing if they are composed of good material and properly applied.

Some of our shop buildings at Chicago, which were built in 1871, were furnished with slate roofs, and those which had the slate fastened with copper nails are yet in good condition. Where galvanized nails were used we have had to repair them.

On some of our suburban stations, constructed in 1896, we used tile. One of these we have had to renew this year. This tile was supposed to be practically indestructible, but it seemed to granulate and go all to pieces, quite suddenly. We could notice the formation of little yellow or reddish spots, and soon after that it would disintegrate. The concern whose tile was used renewed the roof at its own expense. Some of the other tile roofs, put on at the same time and by the same firm, are still in use and appear to be in first-class condition.

Mr. Sibley:—About the roofs dripping:—This work was in Chicago, and I think it is quite a common practice with contractors to mix tar with their pitch. That probably accounts for the tar dripping from the eaves or working through the roof. The terms pitch and tar are not always understood, but at normal temperatures pitch is a solid and tar is a liquid. It is not practicable to use a coal tar pitch with a melting point under 135 or 140, and that is not sticky enough to damage the costumes of the ladies even in the hottest of weather. If it was soft or tarry enough to do that, it must have been caused by mixing tar with the pitch, which is done for the sake of economy, because the material spreads easier and goes further.

Mr. O'Neill:—I think that under certain circumstances there will be considerable drippage, even where pure commercial coal tar pitch is used. I put a roof over a boiler room on book tile, the one I spoke of before, and had considerable trouble with the seepage through the book tile and the lath which were put on to fasten the first layer of paper to. Of course, the conditions were not very

good; it was right over the boiler room and it got pretty hot up there, but it took almost a year before it got through dripping, and it was a pure commercial coal tar pitch.

The President:—I think this report is a very valuable one and the discussions which have been brought out, both by our own members and Mr. Coburn and the representatives of the roofing fraternity have given us considerable food for reflection. We all agree that the solution of the problem is simply a matter of continuous investigation and study. I believe that the report should be received as information and continued until next year, and I would like to have the opinion of the members. I think we would gain, in that we would get additional information. As Mr. Coburn has said, in his report to the American Railway Engineering Association, the subject is one of continuous study. Was not the report so received in your organization, Mr. Coburn?

Mr. Coburn:—Certain conclusions were adopted but the report was considered incomplete.

The President:—I would suggest that some one make a motion to that effect, in case it is agreeable.

Mr. Lichty:—I would say, for the information of all concerned, that Mr. Fullem admitted that the report was gotten up in rather short time, and he thought they could improve it considerably if it were carried over. For that reason, I, personally, should be very glad to see it continued. I think we would get some very valuable information in addition to what we now have. The discussions tonight will make good material for our proceedings.

Mr. Andrews:—As a member of that committee, I think I can say that the committee did not consider the report as conclusive. We felt that we had gained all the information possible at the time, and we compiled the report accordingly. In the discussion tonight and in any discussion that might take place in the future, there are undoubtedly questions which will come up that will be of value to the committee. The only thing that I can see brought out tonight is the question of the relative value of coal tar and asphalt. Now if the manufacturers of the different products are willing to give the committee all the information that they ask for relative to the composition of their product, then I think it would be a good thing to carry it over, but unless they do, I see no benefit whatever in carrying the report over to the next meeting or to any other meeting. I am however, willing, as a member of the committee, to work on it another year, or two years or three years, if this association so desires.

Mr. A. S. Markley:—I believe we should continue the subject another year, because of some criticisms in the report that I couldn't catch or carry in my mind, in reference to tile and slate being an ornament rather than a roof. If it is carried over another year, I will be able to say something about that.

Mr. Andrews:—I do not think that any one is entitled to say that slate is an ornament.

Mr. O'Neill:—How much easier it is to criticise than to give advice of any value! We can all criticise, but I do not believe that many of us can give advice of any value as to the difference between a coal tar and an asphalt roof. I have had considerable experience with these roofs, but I am not prepared to say which is the better. I have had good roofs of each material and I have had some very poor ones, and this question is purely an educational one. We are all at the beginning yet, and I think this committee, if the subject is carried over, can get some information that will be of value to us in the future. I move that the report of this committee be accepted as information, and that the subject be continued for another year.

(Motion seconded.)

The President:—Before putting the motion, I wish to say, that it would seem advisable to continue the committee as well as the subject, because it would be a matter of immense regret if the experience of the committee thus far should not be taken advantage of.

The motion was carried.

Mr. Wardell:—I wish to state that we will be glad to have any gentlemen interested in this subject, visit our mill, go into the manufacture of the fabric as well as the peculiar substances that we use, from beginning to end; and I will come from New York to meet any committee or any individual that is interested, and will not only explain the methods we employ, but will show the material and give them, as well as I can, the reasons why we use the material. There is nothing that we have that we wish to keep secret. There is nothing that we have that every other manufacturer cannot get just as well as we do, if he is willing to pay the price. The only thing we ask is to have the gentlemen of this committee give us their time and attention, if they will, and we will do our best to give them every bit of information we have on the subject.

SUBJECT No. 11.

METHODS OF PROTECTING EMBANKMENTS AGAINST CURRENTS AND RESTORING THEM WHEN WASHED OUT.

(Continued from last year.)

REPORT OF COMMITTEE.

We submit as our report a detailed description of practice in the protection of railway embankments and river banks in nearness thereto, as contained in several letters from members of our association, together with descriptions and illustrations of brush mattress work by the Mississippi River Commission, and of the Kerr gabion system. All of this information appears to us to be practical, and applicable to railroad situations, for it is frequently the case that vanishing river banks threaten the foundation of a railroad paralleling the stream. The only escape from destruction then lies either in changing the location of the railroad or in preventing further encroachment of the erosive currents. Therefore, railroad embankment protection often resolves itself into a scheme for river bank protection. When railroads have extensive works of this character to construct much valuable information that is of direct application can be obtained from the annual reports of the chief engineer, U. S. Army.

Individual contributions to our report, which came in response to inquiries on the subject by the committee, now follow.

R. H. Reid, Supervisor of Bridges, Lake Shore & Michigan Southern Ry.:—On the L. S. & M. S. Ry. we have used several methods of embankment protection. One kind is heavy breakwater stone, where there is washing and pounding of waves, as, for instance, along the shore of Lake Erie and along Sandusky Bay. This protection is sometimes supplemented by filling in between the large breakwater stone with smaller ones, which can be thrown off the cars by hand or shoveled off with train plows. The breakwater stone can be placed to advantage, of course, only where they can easily be rolled down the bank or where the work is within range of a derrick boom.

Another method of embankment protection is the use of barbed wire or woven wire fence, which is sometimes spread along the embankments where water is cutting or washing, and sometimes is filled in with underbrush or other material so as to form a mat, making, in many cases, a very effective protection.

Another form of protection is to spread brush wood or underbrush along an embankment, covering it over with lighter and similar material which will interweave with the brush and form a solid mat, similar to that formed by the woven wire fence.

Another method, which has been used at times, is to drive a row of piles along the embankment which is in danger, sometimes also placing plank or timber on the back of the piles and filling in back of them, laying the timber as low down in the water as possible, in order to prevent undercutting. This frequently affords a very effective protection against wave washing as well as against the action of the current of streams.

J. M. Bibb, Supervisor of Bridges and Buildings, Louisville & Nashville R. R.:—One way to prevent an embankment from being washed out by river current, where the current strikes the fill, is to riprap the side of the fill with stone. To protect the off side of the embankment from being washed in event the flood should not go over the track, that side also should be riprapped. Should the current begin to cut under the track the action can be stopped by throwing in gunny sacks filled with sand or common dirt.

What to do after an embankment has been washed out depends largely upon circumstances. If the fill washed out is not more than 10 or 12 feet high, the quickest way to resume traffic is to crib up a support for the track with ties or other timbers or erect temporary bents, but if the water is in the way, especially if the current is swift, the best thing to do is to drive pile bents and build over them. If a driver is not available, place the posts and work them down to as good a bearing as possible; cap them and run cars over to settle them down, and keep blocking up until they are down.

At the Alabama River, where the L. & N. R. R. crosses near Montgomery, we discovered last summer that one of the spans had moved a little, and it was decided to have divers make an examination of the foundation of the piers. Upon investigation we found the round pier under the draw span, and also the pier on each side had been very badly undermined. The material under the round pier had washed out on one side about 8 or 9 feet deep. The water was about 12 to 14 feet deep, at low stage, with some current. We placed 30 or 40 carloads of large stones from ½ cu. yd. to 1 cu. yd. in size around the pier, but 5 or 6 ft. clear of the pier, and piled them up within 2 or 3 ft. of the surface of the water. We then lowered concrete in iron buckets 3 ft. square, with drop bottoms, down to the bottom of the river and dumped the concrete until we put in about 80 or 100 cu. yds., which is standing all right now. Our object in dumping the concrete between the pier and the stone that we placed around the pier was to compel it to run under the foundation.

J. M. Mann, General Foreman, Ft. Worth & Denver City Ry.:—We have been figuring on putting in some concrete slab protection, but owing to the slack period in business we have not done this work yet.

We have had a great deal of experience on the F. W. & D. C. Ry. in protecting our banks, as there are a number of rivers and we have been fighting them for a good many years. For riprapping banks, where it is not necessary except in case of overflow, I think rubble stone is about the best thing to use. We are putting in stone on banks for about 30 cents per square yard. Wherever we lay up the stone in shingle fashion we have never had any trouble. We have a number of banks approximately 10 ft. high which have been riprapped in this way for eight or ten years, and frequently the water comes up over them to within 2 ft. of the ties; and yet we have never, in any instance, lost a bank when protected with rubble stone in this manner. Of course, I would not recommend such work for streams where the banks are caving in.

On river banks we get best results by putting in cribs or pens about 10 ft. wide, flooring them with old stringers or poles. We build the crib in the water and sink it with stone as we build it, the crib to connect with the bank at the upper end and extending out into the stream at an angle of about 30 deg., pointing down stream. We build them to stand 8 or 10 ft. above high water. As the water rises the crib settles, in most cases, but we keep building them up and filling them with stone as fast as they settle. After two or three floods the crib will stop settling and a sand bar will form at the back of it, after which we have no further trouble. This work costs us, all told, approximately $1.50 per cubic yard, including the stone placed in the crib and the material used in making the crib.

We have also tried to protect a number of places from washing by placing barbed wire fence along the bank, anchoring it out in the river and letting it float. So far we have not had much success with it.

C. F. Green, Supervisor Bridges and Buildings, Southern Pacific Co.:—The rivers in northern California are very peculiar, inasmuch as they have been filling up for years with slickings washed from the mountains by hy-

draulic mining, so that at the present time the beds of the rivers in some places are higher than the adjacent land, and the banks must be protected by levees. We have five rivers and numerous smaller streams on the Sacramento division that we either run along or cross, and during high water we are kept constantly on the watch for washouts. All openings, such as trestles and culverts, are riprapped with granite rock or willow mattresses, but we find the cost of granite rock high—about $3 per cubic yard, in place. The mattress will not last, so we are now using concrete matting of 6 inch thickness, reinforced with fence wire, which we find is much cheaper than the granite rock.

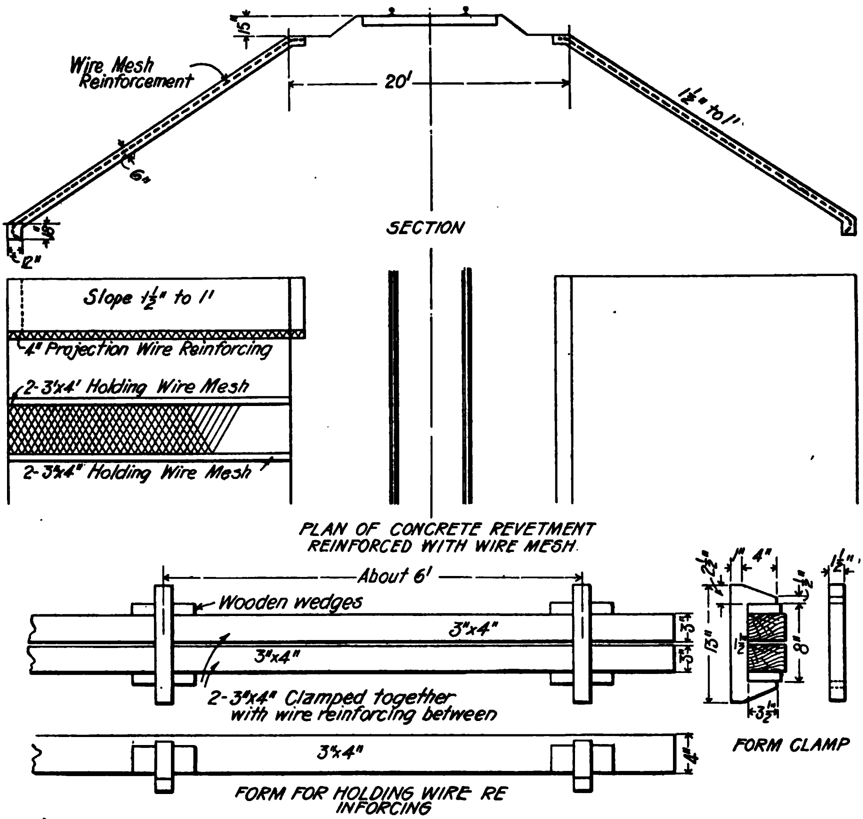


Fig. 1.—Reinforced Concrete Slab Bank Protection, Southern Pacific Co.

TEMPORARY PROTECTION OF EMBANKMENTS WHEN PERMANENT WORK CAN NOT BE DONE.

For years past, in times of high water, the Southern Pacific Co. has used granite rock by the car-load, dumping the same down the embankments to stop the washing, but we find it unsatisfactory for the purpose unless used in large quantities. We also find it slow material to handle, and during later years on this division we have used the brush mat, which can be placed in current swift enough to wash rock away weighing a half ton. If possible we cut the brush as long as the slope or bank of the washed fill and make it

into bundles by tying together with baling wire or small rope about every 3 ft. along the bundle, which is as large as can be carried by three or four men. We then place these bundles along the track at the wash, close together, the small ends projecting toward the water, and fasten the bundles together with baling wire until we have bundles the full length of the wash. We then take a heavy line that will hold the mat in the stream, make fast one end of the line around the down-stream bundle at about the middle, and from that around all other bundles, until we come to the last one up stream, where we tie the end of this line to a tree or dead man up stream where it will hold the mat against the washed bank when afloat. Next we take a number of small lines (old ones will do) about the length of the bundles, fasten one end of these lines to the bundles, about 20 ft. apart and at the end next to the water, bringing the lines up lengthwise of the bundles. We then start at the up-stream end of the mat and shove it overboard, holding on to the short lines, so that the mat will not swing away from the bank or clear of the bank. In fact, we leave about two or three feet of the mat on top of the bank after shoving into the water. We then take some worn-out rail, long enough to reach from line to line fastened to the outer ends of the bundles and, starting at the down-stream end, hold up the short line and heave out the rail upon the mat as far as possible under the short lines, and continue doing this the full length of the mat. The rails will sink the mat down, and if we get the rails out on the mat where the small ropes are fastened, by hauling in or letting out on the lines we can bring the end of the mat right to the base of the wash and stop it.

We have found the brush mat made in this way the most feasible plan in times of emergency. In fact, we stopped washing action 18 to 20 ft. high and 200 ft. long, at points back of a U-abutment of an approach to a steel bridge, by using a brush mat in this manner.

PERMANENT PROTECTION OF EMBANKMENTS.

On revetment work we have used riprap of split granite rock or round rock dumped on the fill, with no satisfaction unless placed in large quantities; but if laid with the face chinked and pointed up it will make a fairly good job. The trouble with this kind of work is that the fill gets wet and settles, breaking up the face of the rock until the water scours out the fill back of the rock, thus displacing large masses of it. We are now using, and have been using for the last two years, a concrete slab of 6 inch thickness, with a wire netting in the center of the slab as a reinforcement. We find this a very good device, and it is cheap. In one case where it was placed on a new fill that settled badly, it did not pull apart and did not allow the water to wash the fill.

Following is the cost of a reinforced concrete revetment of 6 in. thickness for a works of 376 sq. yd. surface measure:

MATERIAL.

2 rolls fence wire, 50 rods, at 45c per rod,	$ 22.50
82 cu. yds. gravel and sand at 30c per yd.,	24.60
82½ bbls. cement at $1.70 per bbl.,	140.25
Total cost of material,	$187.35

LABOR.

Building mixing platform,	$ 11.50
Unloading gravel,	25.00
Unloading cement,	10.50
Putting up forms and reinforced wire,	116.50
Placing concrete,	119.00
Total labor,	$282.50
Total cost of material and labor,	469.85

The design of the slab is shown in Fig. 1. We graded off the slope to the standard 1½ to 1 slope and dug a trench 12x18 ins. around the bottom of the slope, placing the end of the wire in the center of the trench, allowing the wire to lie away from the slope. We next filled in the trench with concrete. When this was completed we took a piece of 3x4 in. lumber, the length of slope, and placed it up the slope at the edge of the wire and another piece, with one width of the wire over them. We then took two other pieces of 3x4 and placed them on top of the first two pieces, and, by using molder clamps and wedges, clamped these two pieces together so as to hold the wire tight between them. We then cut some 1x4-in. pieces about the length of the width of the wire, and drove them between the two top pieces of 3x4 in. This stretched the wire up tight and gave us 3 inches under the wire and 3 inches over the wire, also leaving, after the concrete was in place, when the four pieces of 3x4 were removed, 4 inches of wire sticking out of each side of the concrete slope.

This was done with alternate sections of wire which gave us a space up the slope without walking on the new concrete. When all of the odd widths of wire were in place the length of the revetment, we started and took out the 3x4 in. forms and then laid the alternate sections of wire. These were fastened to the stub ends of wire that were left sticking out of the first concrete by tying it with small wire. We then filled in with concrete. This gave a continuous wire in the center of the concrete throughout the revetment and made a good-looking face.

I think this work will stand longer than any other kind that we have tried. I give the cost per day of the gang, so that the cost of the labor can be compared as against work at other places where cheaper labor can be had. We worked 10 hours per day. We had one foreman at $4.50 per day; one concrete mason, at $3.25; six laborers, at $2.25; three laborers, at $2.50.

A. M. Van Auken, Chief Engineer, Memphis, Dallas & Gulf R. R.:—Roughly, we may describe bank protection as falling in three classes:

(*a*) Where the banks and bottom of the stream are stone, stony or consist of other substance not washable by the force of the current, and where it is only the railroad grade that is to be protected.

(*b*) Where the bank and bottom, or at least the bottom of the stream, are of gravel or coarse sand and have considerable resistance to the washing power of the current.

(*c*) Where the soil is alluvial, and the rivers shift their courses at will.

As to treating these various conditions there are many methods. We may, however, classify the successful ones as four. For Class "a" there seems to be nothing equal to riprap. There is but little need to speak of this here. It consists of stones laid, or, even thrown, on the slope of the roadbed at points where injury is threatened. The size of the stone used is governed by the velocity of the stream, the drift it carries, and the ice forming in it. Ordinarily the needed size may be judged by the size of the stones left in the bed of the stream. If these be not larger than "one-man stone" (of a size readily handled by one man) the embankment will be safe if protected by stone of that size. There is seldom any economy in using stone smaller than this.

Mountain torrents, streams carrying large drift and, worst of all, streams which freeze deeply or carry heavy floating ice, present serious problems for riprap. Where ice forms a foot or more thick against a bank the rising water will lift heavy stone from place. Under such circumstances only very heavy stone, placed with a derrick, will give adequate protection.

For Class "b" a form of protection recommended by Mr. A. E. Killam will usually give most excellent results. On the Wisconsin and upper Mississippi Rivers wing dams built of brush weighted with stone have given most excellent protection, at points where the stone used as riprap would soon be buried by their own weight sinking them in the sand. This form of protection, like riprap, is so common, and the differences in the way in which it is used are of such minor importance that a more complete description is hardly necessary—it is merely riprap with a foundation of brush.

For Class "c" there seems to be no best system. If you will recall

your individual troubles in controlling water on leaky roofs, in leaky pails and in leaky cisterns you will have in mind what a volatile and capricious substance you are dealing with. Then, given such a stream as the Arkansas, Red or Missouri or Mississippi, with a flood volume running up into thousands of feet per second of discharge, the velocity with which it moves at flood time, and the impact with which it strikes the bank, and you will realize that no form of protection should be expected to hold against the ever changing attack of so powerful a foe unless such protection is constantly watched when threatened, and strengthened as the force of attack changes to the weak or weakened points.

Then we have the further problem of continual changes in a channel due to various construction operations in and adjacent to a stream. The erection of a bridge pier or boat incline may change the course of a stream to an astonishing extent. The slight increase in the velocity of the stream at a particular point, say from 2.94 ft. per second to 3.06 ft. per second, will destroy a bank which would have resisted indefinitely under the former condition. A snag or sunken steamboat may cause this. The successful control of a large stream, as the Missouri below Sioux City, and the Mississippi below Grafton, requires constant and intelligent watching.

The forms of protection which have given entire protection successfully on these streams are two. The first, and undoubtedly the best, is the mattress. Where brush are procurable at a fair cost they are commonly used. On the lower Mississippi mattresses have been built of cypress boards. This method is described in Camp's book on track, and in an article in the Engineering News, June 5, 1902, by Mr. W. R. De Witt. Mr. De Witt speaks from many years' experience with rivers of this class, and no one, to my knowledge, is equally well informed as to the particular problems there presented.

The only other system which has given any measure of protection in this class of stream is the permeable pile dike. This consists of from two to four rows of piling driven at right angles to the bank, framed together and braced to resist the action of ice and drift. On the up-stream row are fastened two or more rails, much as are the rails of a picket fence, and to these are fastened, perpendicularly, poles which reach the bottom, and extend nearly or quite to high water. It is very much in form like the common picket fence. Its action is to retard the flow of the water, as it passes through it, and cause it to deposit silt in the comparatively still water below the dike, thus building up a deposit or sand bar, and ultimately cultivable land. These dikes must be so close together that the eddy caused by one dike will be caught by the dike next below and broken; otherwise the eddy would wash out and destroy the deposit.

The mattress style of protection is best, but is more costly. Its only failures, to my knowledge, are where the protection was only partial. If the mattress does not go out to the central thread of the deepest water of the stream, the water will work under the edge and destroy the mat. If it does not extend to a point above, and to a point below, where the force of the stream strikes the bank, the water will cut around the end of it and destroy it. Of course, the bank of the stream above low water, and extending to above high water, must be protected by our friend riprap. With the permeable pile dike it is usually necessary to protect the bottom of the stream under the dike with a mat.

The failures at bank protection works are legion. Among those which had great ingenuity back of them were the "fox-tail" dikes experimented with on the Missouri River in the latter seventies. They were composed of saplings somewhat longer than the water was deep, the lower end anchored to the bottom by a rock of sufficient weight to hold it in place and the top attached to a barrel to keep it afloat after it became clogged with deposit. As a temporary expedient these dikes are a great success. They will divert a current of water from a bank in flood time, and may be used to save a town from a river change during high water, as they can be planted in any stage of water, and if one be washed away another can be planted to take its place. As a permanent protection they are of little use, each succeeding high water calling for more or less renewals.

The most complete failure was with what were called "bankheads," much used on the Missouri in the later years of the Missouri River Commission. Briefly, it consisted in forming the bank into easy bends, and protecting the point or promentory, the theory being that the river would then form into a bend around the bankhead and behave itself. It refused to behave, and the work, costing a couple of million dollars, failed utterly in accomplishing its end.

Numerous "systems" have been brought out, tried with indifferent success, and, so far as I know, all ending in complete failure. Those who may wish to read up I would advise procuring from the chief engineer, U. S. Army, the appendixes to his reports covering the streams in the vicinity of his work. The report of the Mississippi River Commission has the most material of value. The two engineer districts covering the Mississippi from Cairo to Grafton and from Grafton to St. Paul, and those covering the Missouri, the Arkansas and the Red are the most useful to an engineer having to deal with alluvial streams.

A partial list of the articles in periodicals relating to this question are as follows:

"Bank Fascines," Engineering News, March 26, 1896.

Banks to Resist Wave Action—Proc. Amn. Soc. C. E., Nov., 1896; Trans. Assn. C. E., Cornell, June, 1896; Engineering Magazine, Dec., 1897; Nat'l Geographic Magazine, June, 1901.

Bank Revetment—Engineering Magazine, June, 1896; Proc. Amn. Soc. C. E., June, 1896; Engineering News, Oct. 31, 1901; Engineering News, June 5, 1902; Proc. Amn. Soc. C. E., Jan. and April, 1905; Engineering Record, Aug. 18, 1906; Engineering News, Oct. 22, 1908; Engineering News, Dec. 10, 1908; Engineering News, Jan. 14, 1909; Engineering News, Jan. 28, 1909; Engineering News, April 8, 1909.

If time would permit I would like to give a history of the two cases at Eliza Point, Ill., and Bird's Point, Mo., just above and opposite Cairo, Ill. The Bird's Point case was treated by makeshifts and Eliza Point was protected. The former work resulted in a loss of property of close to $150,000 by the St. Louis, Iron Mountain & Southern Ry. and the St. Louis Southwestern Ry., and the latter saved the city of Cairo from being cut off and left on an island.

BRUSH MATTRESS WORK OF THE MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission is now weaving and sinking a fascine mattress at Delta Point, La., opposite Vicksburg, Miss., for protecting the river bank which is caving and encroaching the right of way of tracks of the Vicksburg, Shreveport & Pacific Ry. The photographic reproductions and line drawings convey a good idea of how the work is being handled. Fig. 2 shows the mattress barge and the process of weaving the mattress; Fig. 3 shows the mattress floating in the river as the barge is worked away from the completed part of the mattress; and Fig. 4 is a view looking over the mooring barge, at the head of the mat and towards the mattress barge. Figures 5, 6 and 7 illustrate the method of making the fascine mattress.

A thorough knowledge of the river in the vicinity of a reach to be protected is of great importance. Much money can be wasted by not studying the movements of currents and bars in the locality, in order to select the best point for beginning the work. If placed too high under the bar, dead water may soon prove it a waste of material and an unnecessary expense, while at localities where the bar is receding the failure to place the upper end of the work at the correct place may prove disastrous. A careful survey of the river in the vicinity is very essential.

A mattress 300 ft. wide by 1,200 ft. long represents a superficial area of about 8 acres, and when one realizes that this vast willow carpet, over a foot thick, is placed on the bottom of the river in depths of from 40 to 100 ft.,

Fig. 2.—Mattress Weaving, at Delta Point, La.

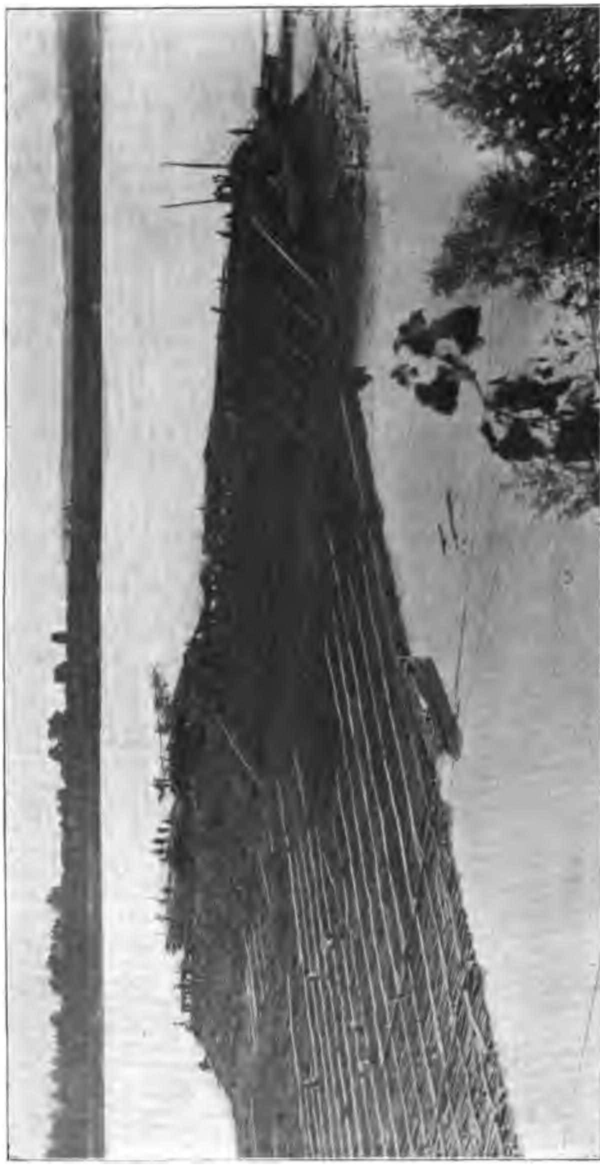


Fig. 3.—View of Mattress Weaving, Delta Point, La.

Fig. 4.—View from Mooring Barge to Weaving Barge, Delta Point, La.

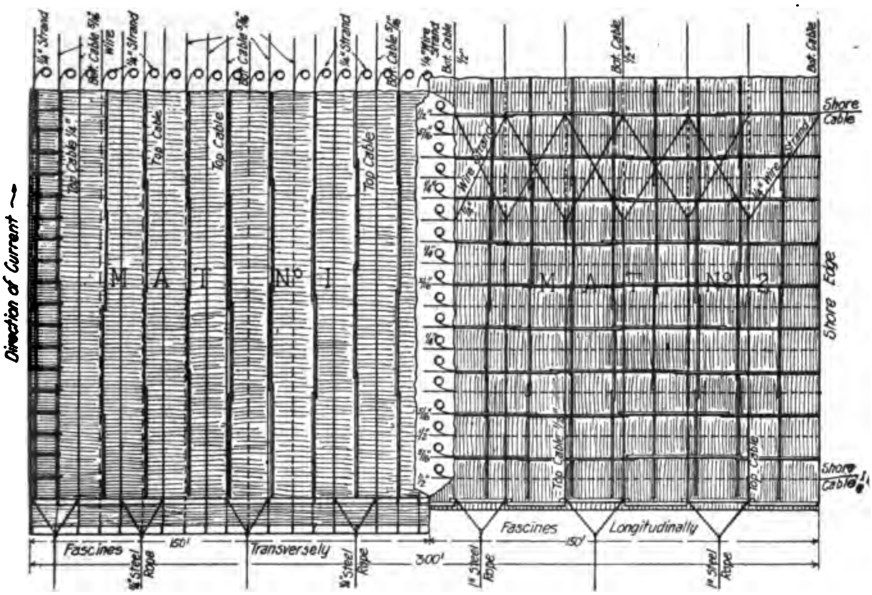


Fig. 5.—General Plan of Fascine Mattress.

and against currents of from 5 to 8 ft. per second, the difficulty of the enterprise will be appreciated.

A complement of men for a mat 200 ft. wide is 54, under a foreman, divided into three equal gangs, each under a master laborer. Each gang consists of five men on the brush barge passing brush to the weaving party, twelve men in each weaving party, and one man on the mat mauling the brush tightly into place as the weavers push it down. Each gang builds one-third the width of the mat. The brush barge is placed outside (below) the mattress barge, about midway between the two ends, and a barge loaded with poles is hung to each of the said ends.

We give below, from a report of the chief of engineers, U. S. Army, cost data and the method of building a fascine mattress during the season of 1893 at New Madrid, Mo., which was the first large fascine mattress made. The work consisted of a continuous mattress 250 ft. wide by 900 ft. long and 12 inches thick, an auxiliary connecting mattress, and a shore paving of 4 in. of spalls and 6 in. of stone extending up the graded bank to the 27-ft. stage. The cost of this work per lineal foot was as follows: River mat fascine, $15.62; connecting mattress fascine, $2.32; paving mat fascine, $7.58; superintendence and care of plant, $2.26; total, $27.78. During the construction of the mat the weather was very favorable, and the river remained practically at the 10-ft. stage.

Labor:—The supply was not very abundant. Whites, subsisted by the government, were employed in all responsible positions. At first the common laborers were white and self-subsisting, but owing to the hot weather and hard work, they were soon replaced by negroes. The price paid was $30 per month and subsistence. The self-subsisting laborer received $1.25 per day of eight hours.

Material:—Brush and poles were obtained by contract at $1.05 per cord for the former and $1.50 per cord for the latter, and the source of supply was from 10 to 30 miles above the work. The deliveries were not sufficient, owing to the fact that the estimated quantity to be used per day was too small. Stone was obtained by contract from the quarries and stores on the bank during the spring.

Fascine Mattresses:—The method of holding the barge and the mat, by means of cables fastened on the bank, was the same as in previous years.

A set of platforms or fascine barges were used in addition to the mat barges, and joined to them longitudinally. The platform barges were ordinary barges with an extra deck raised to the level of the platform of the mat barge. Along the side of these, joining the mat barges, forms were built in which to construct the fascines, the tops of these formers being at the same elevation as the highest point on the mat ways. Under the platform of the mat barges were placed 19 reels 13 ft. apart, the two outside reels containing 3/8 in. and the others 5/16 in. galvanized steel strands (made of 7 wires each). These are the bottom cables, and the ends of each were made fast to the head and under the mat at right angles to the fascines. Each cable was in one piece, its length being determined by the length of the mat. Friction brakes were used on the reels to keep the cable taut.

The method of procedure during the construction of a fascine mat was: First a large head, about 3 ft. in diameter, was made of hardwood poles, the diameter of the butts of the poles being from 4 to 8 inches, and to this head were fastened the bottom cables. The weaving strands, which were 1/4 in. galvanized steel strands, composed of seven wires, were also fastened to the head at the same place as the bottom cables, and hence there were nineteen of these 13 ft. apart.

The fascine was made by placing brush from 1 to 4 inches in diameter at the butts in the formers and compressing them into round bundles or fascines 12 in. in diameter, by means of the lever chains. While thus compressed they were tied together with No. 12 galvanized steel wire. Care was taken to keep the butts well scattered. The fascine was next raised out of the formers and pushed to the ways and down to the head, when the weaving cables were passed over the fascine, then down under the fascine, and the bottom strand up between the fascine and the head. Then a pair of 6 in. blocks, one end fastened to the mooring barges and the other (by means of a "Haven" clamp) attached to the weaving strand, and six men at each set of blocks pulled the fascine down to the head. While the strain was on the weaving strand it was either clamped to the bottom strand or held so that the fascine could not separate from the head, or one from the other,

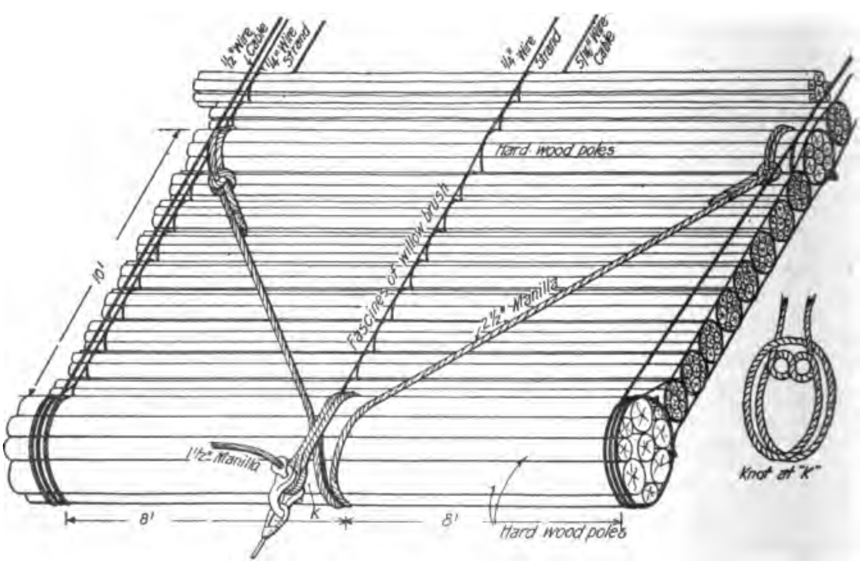


Fig. 6.—Part of Head in Mat. No. 1.

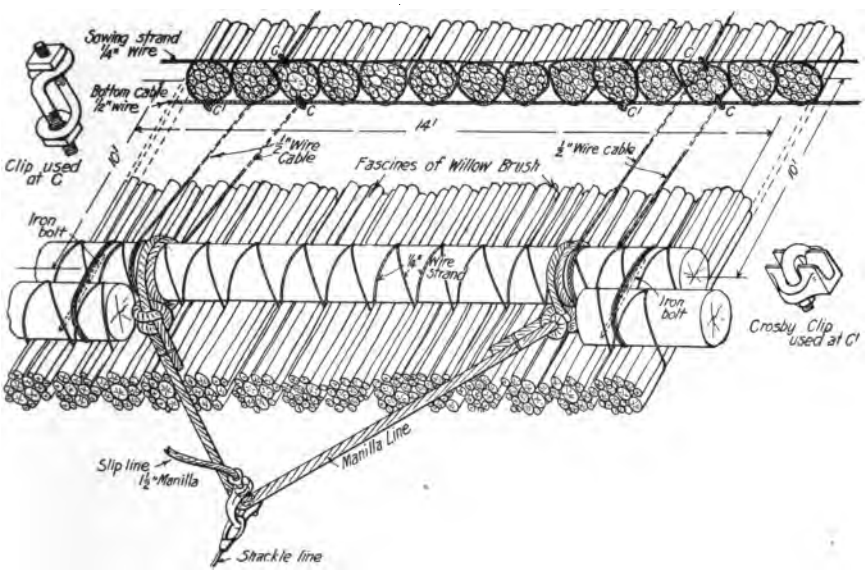


Fig. 7.—Part of Head in Mat. No. 2.

by driving a staple into the butt of a willow so as to take both the weaving and bottom cables. The weaving and bottom cables were clamped together, at every tenth fascine, besides being stapled, so that the fascines could not slip apart. This method was continued until the mat was built of the desired length.

The labor on the mat was divided into three parties: One party unloaded the brush off the barges; the second party carried the brush to the formers and made the fascines; the third party assisted the second in raising the fascines out of the formers down on the ways and tied them together. When the ways were filled, the friction brakes were raised and the launch made, the brakes being put on again just before the launch was completed, so as to get a uniform strain on each cable.

In order to strengthen the mat, five longitudinal wire strands, 26 ft. apart, were placed over its whole length. The first one was on the outside of the channel edge, and of ½ in. diameter, composed of nineteen galvanized steel wires; the second was also ½ in. and the remainder were ⅜ in. diameter, composed of seven wires. These strands were fastened to the head of the mat at the same place as the other strands, and were clamped to the weaving strands at every tenth fascine, the clamps being so arranged as to come half way between those on the bottom of the mat.

The shackle straps were fastened to the mat by first taking a turn around the head, then circling two or three fascines about 10 ft. from the head, and next clamping to the top strands. Seven shackle straps were used, the two nearest the shore not being backed up with a top strand. In order to give the mat the necessary rigidity in sinking, longitudinal poles of 3 to 8 in. diameter at the butt were placed over it, the rows being 13 ft. apart, and fastened to the mat with No. 12 galvanized wire and No. 9 copper wire. The ties were 4 ft. apart, one of copper and the next two of galvanized wire. These wires encircled a fascine and a pole. Care was taken to keep the galvanized and copper wires well apart, so that no chemical action could take place and destroy the wires.

At first the progress of the construction was slow, owing to the fact that the labor was untrained and that the fascine mat was an experiment;

but after the details had been worked out fairly good progress was made. Mattress construction was begun on July 27 and completed on August 16, when the mat was sunk.

Brush used per square, cords,	$1.60
Poles used per square, cords,	.05
Stone ballasting, cubic yards,	.57
Total cost of mat per square,	$6.25

Grading:—There was not much grading to be done, as the bank had nearly a 1 on 3 slope, except at the upper end, where graders had to be used. Hydraulic grading began on Aug. 17 and was completed Aug. 25.

Bank graded, linear ft.,	360
Material moved, cubic yards,	2,154
Cost per cubic yard,	$ .08

The excessive cost was due largely to a pile of very compact sawdust which was removed with difficulty.

Connecting Mattresses:—Narrow connecting mats were placed along the entire bank protected, as the river mat did not come up to the water's edge. These were built on the ways, of the old type of mattresses, and then launched in place.

Total length of connecting mats built, including laps, linear ft.,	1,000
Average width of connecting mats, ft.,	15.15
Total built; 155.5 squares, sq. ft.,	15,550
Brush and poles used per square of mat, cords,	4
Stone (ballast and sinking) per square of mat, cu. yds.,	$ 2.50
Cost per square foot in place, cents,	15.63

The quantity of stone used was large, as an extra amount was placed on the mat from the zero to the 10-ft. contour.

Paving:—Preparatory to paving, the grade was neatly dressed. Paving began at or near the 8 ft. contour and extended to the 27 ft. contour. The spalls used in paving were from 1 to 10 pounds in weight, and the stones weighed from 10 to 40 pounds. The average thickness of the paving was 10 inches, 4 in. of spalls and 6 in. of riprap. The length of bank paved was 900 ft.; the area of bank paved 8,001 sq. yds. The total cost, exclusive of grading, was 8.35 cents per square yard.

SUMMARY.

	Per Linear Foot.
River mat, 900 linear ft., 2,250 squares, cost,	$15.62
Connecting mats, 900 linear ft., 155.5 squares, cost,	2.32
Paving, 900 linear ft., 72,008 sq. ft., cost,	7.58
Sundries (superintending, care of plant and repairs),	2.26
Total cost per linear foot,	$27.78

The 900 linear feet of revetment cost $25,000.

THE KERR GABION SYSTEM.

In describing this system it is proper to explain that its development is being fostered by the need of a method of protecting caving banks which would be commensurate in cost with the value of the property requiring protection. The standard rock-filled piling jetties have in cases given good service at costs varying from $8 to $15 per lineal foot of jetty, and in many cases have yielded results directly opposite that for which they were constructed, not infrequently being found, after a few years, on the other side of the river, which has made a new channel behind them. In other cases they are washed into two pieces, the river breaking through the middle.

Fig. 8.—View of Arkansas River, 8 Miles Below Little Rock, Before Installation of Kerr Gabions.

Some of the work of the Kerr gabion system is shown in Figs. 8 and 9. In this case the river was digging a very deep bend at the place toward which the steamboat is pointing and taking away land in large quantities, forming a new channel and slowly closing the old channel to the right of the middle bar shown in Fig. 8 by connecting it with the main bar on the opposite shore. The steamboat is just entering the new channel at low water, the old one being already too shallow for navigation.

At this juncture the owner of the land entered into contract with the River, Rail & Harbor Construction Co., of Jackson, Miss., for the installation of the Kerr gabion system. At a period when the river was high enough to carry a large amount of sand and make the shoal channel navigable, the jetty shown at the upper end of the sand bar in Fig. 9 was put into the swollen stream, with the result that the low water channel was within a few weeks filled with sand and within three months the immense sand bar shown in this picture was built. High water thereafter became more and more sluggish in the old bend and caving grew less and finally ceased. This bar is 1,700 ft. long, 400 ft. wide and the depth of the fill varies from 2 to 22 ft.

This gabion is graded in height from 8 ft. to 16 ft. and is 600 ft. long, being constructed entirely of oak and willow cut near the site, in the manner shown in Fig. 10, which is a picture of a smaller gabion placed at another point. Occasionally steel arches are used in the construction to add weight to the structure, to sink it and hold it to the bottom. The very important feature of anchoring and holding this work in place is accomplished by sinking large concrete blocks into the sand by a hydraulic jet, to which are attached steel anchor cables made fast to the gabion.

The gabion works on the well known law of sedimentation (gravity). A stream running rapidly carries much sand in suspension, sometimes as much as 50 per cent. If the flow or velocity of the stream is then reduced by the introduction of a pervious gabion jetty which allows, say 50 per cent of the water to pass through the same while the other half is shunted around, a

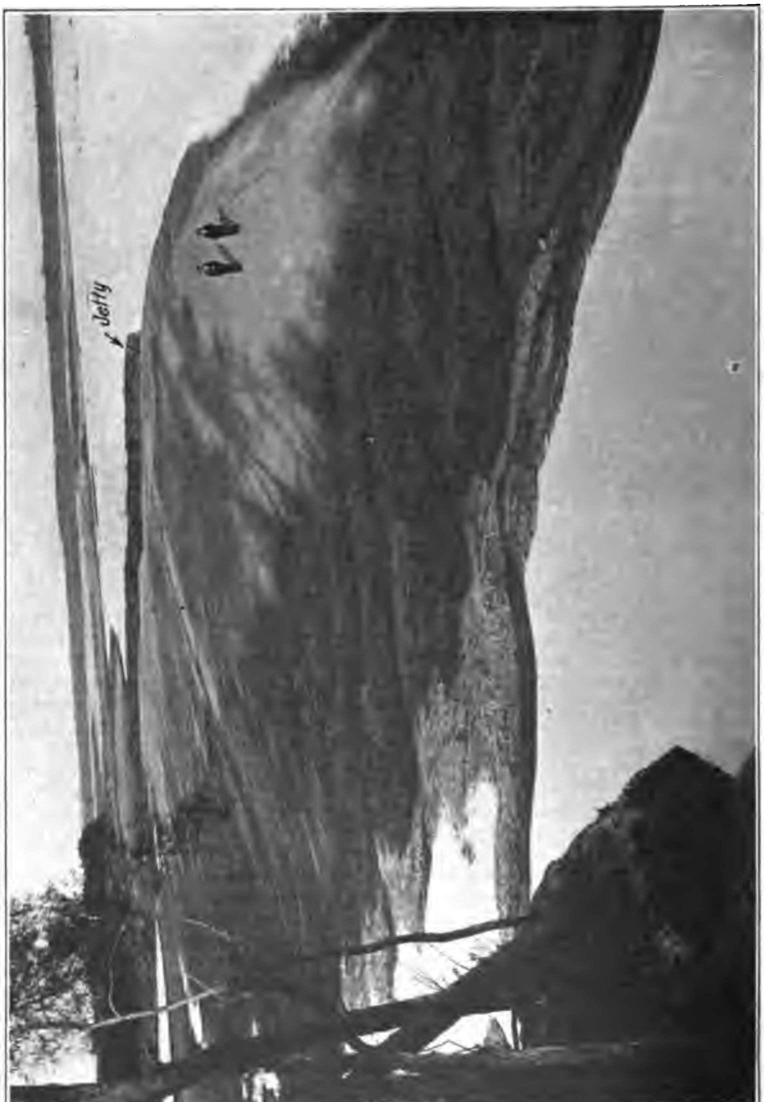


Fig. 9.—View of Spot Shown in Fig. 8, Thirty Days After Installation of Jetty of Kerr Gabions.

corresponding reduction in the velocity of the stream is effected, and a deposit of the sand which it is not able to carry at the reduced flow. By varying the mesh of the lacing one can secure different results in carrying the deposit of sand close to or far below the gabion, as may be desired by the conditions.

The length of the bank protected in this case up to this time is 1,700 ft., not to mention the saving effects of the deflection of the current from the banks farther down the stream caused by the sand bar. All engineers who have had experience with rock-filled piling jetties in our rivers know that substantial precautions must be taken in their construction at the channel ends to offset the destructive effect of the intense eddies set up at this point. The design of the gabion jetty is such that this eddy is broken up into thousands of small eddies devoid of harmful effect. On the basis of the total contract this particular gabion would not cost more than $4,800, and a piling jetty of the same length would have cost $9,000.

Figure 11 shows the plans for repairing an old solid dike at the C. R. I. & P. Ry. bridge in the city of Little Rock, which has been submitted to that company recently. This work is to be put in for the purpose of maintaining the low water channel under the draw span of the bridge. At present the new channel is forming under the fixed span through the gap in the old piling jetty. A similar instance to this is one on the Cotton Belt road at Rob Roy, on the Arkansas River, where the channel moved to the opposite shore, leaving the draw span, so that company has put in another draw span over the new channel. Thus railroads are often put to enormous expense because of delay in taking action, for the control of channels requires time.

The gabion work of the Kerr system in most cases has been made of willow and oak materials secured near the site of the work. Construction for the coast of the Gulf of Mexico, placed to protect a railroad from being washed away by the storms and for building up the beach of the coast along the railroad, which was built to stand the blows of the surf and the breakers during storm, was constructed of arches made of oak bent after steaming the timber, making it very stiff after it was braced on the inside. This work was laced with sawed dimension stripping, all of it being creosoted.

For emergency revetments the work is built cylindrical in form, and the cylinders, one after another, are put to the bottom of the river, strung on cables which have previously been anchored in the bottom of the stream. These cylinders have cross-sectional partitions and they at once deflect the water, acting much as a mattress would act. These cylinders are made as a rule about 5 ft. in diameter and they soon fill up with sand and thus make a solid bank.

Fig. 10.—Constructing a Kerr Gabion 7 ft. High and 200 ft. Long.

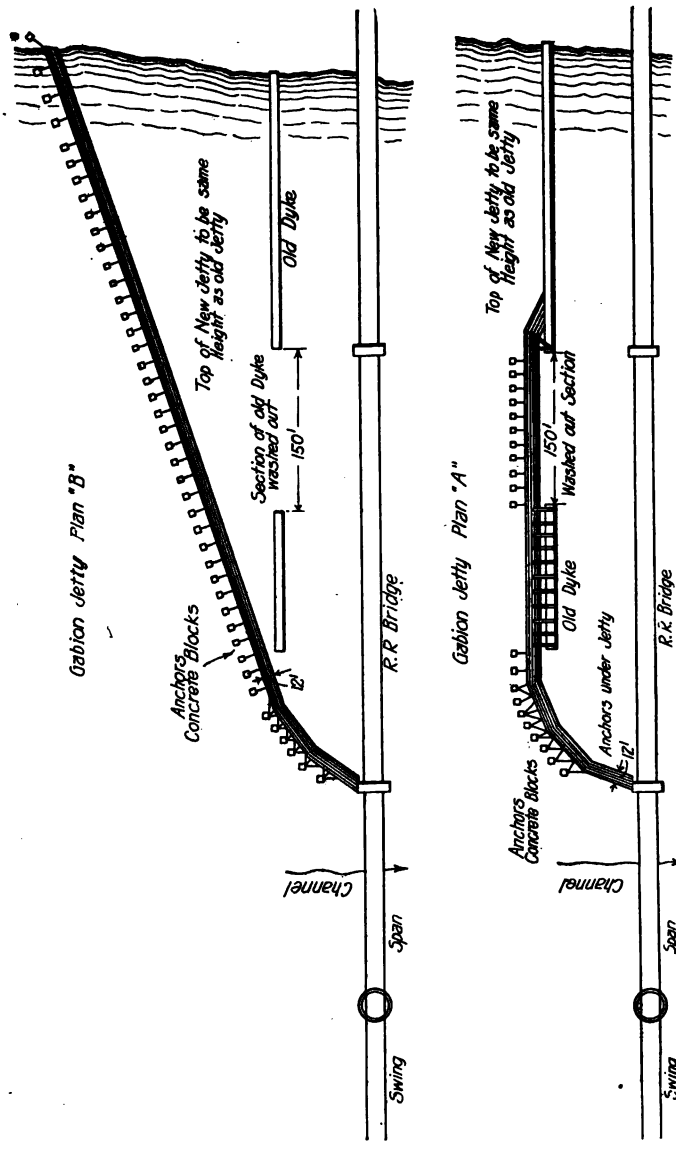


Fig. 11.—Proposed Repairs to Jetty at C. R. I. & P. Ry. Bridge at Little Rock, Ark.

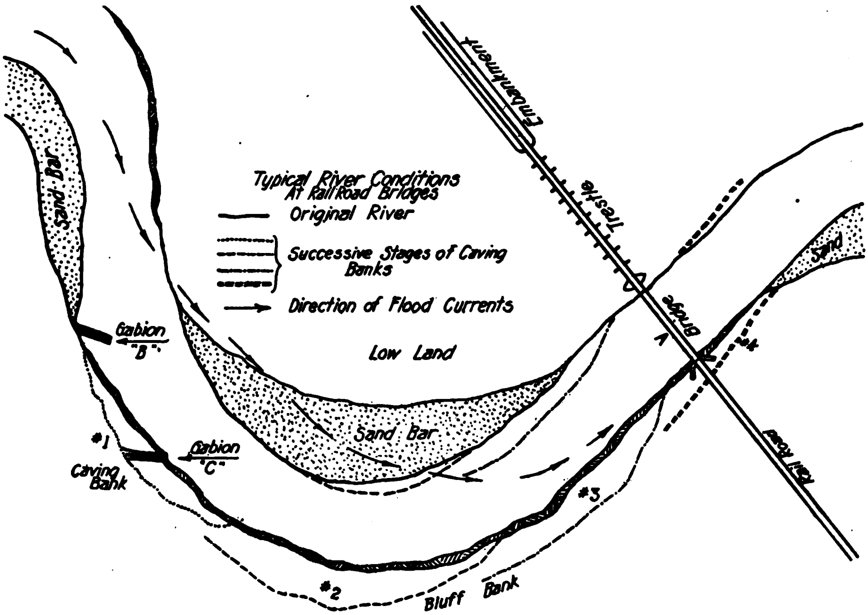


Fig. 12.—Typical River Conditions and Means of Protection of Bridge.

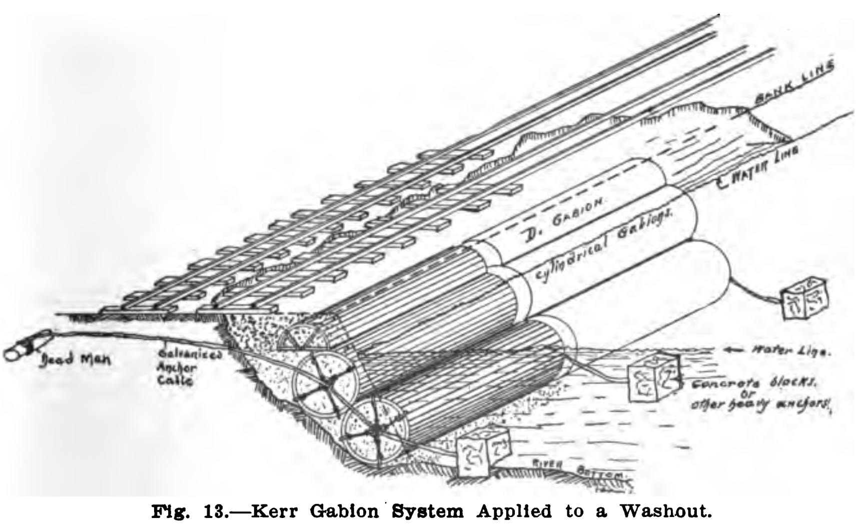


Fig. 13.—Kerr Gabion System Applied to a Washout.

Much trouble could be prevented if the parties concerned would take action in the matter of protecting banks or protecting bridges in time to avoid the crisis, as, for instance, in the case where a river starts to dig a

bend up-stream from a bridge, say a mile away, and it is getting deeper and deeper, and it is known that it is coming around behind the abutment of the bridge when it gets that far down. The proper thing to do is to take advantage of that mile and begin to work with the system, in small pieces. In this way 1,000 ft. of work will afford more protection than 5,000 ft. would do at the time of the crisis.

Where tracks skirt rivers and the river gradually or suddenly invades the right of way, reducing it one-half or more by caving, the only remedy is to fill it up, but while doing this ribs can be put into that body of earth in the shape of gabions. Figure 12 shows typical river conditions above a railroad bridge. The method of protection is to put in Gabion B when No. 1 starts, but if No. 1 is completed put in Gabions B and C.

E. L. Loftin,
Chairman of Committee.

DISCUSSION.

The President:—The next report to be considered is the one on embankment protection, of which Mr. Loftin is chairman. The report is not printed. Is Mr. Loftin in the room? If not the secretary will read the report.

The Secretary:—This report has not been arranged in first-class shape. I will read it as it is. We will have it revised before it is sent to the printer.

(The report was read by the secretary.)

The President:—This is a continuation of the report of last year. It is an interesting subject and we would like to hear a lively discussion of it.

Mr. Van Auken:—This is a matter in which I have had some little experience and have made considerable observation. In the early years of my work I was with the United States Engineer Corps, and served on the lower Mississippi, the Arkansas, the Wisconsin, the upper Mississippi and the Missouri rivers. In railroad service I have often found it necessary to protect the embankments at bridge ends and other threatened points from streams of various sizes. There does not seem to be any best way to treat streams of all sizes. If the threatening stream has a rock bottom, or is in a soil that will not wash, there is nothing quite equal to riprap, if stone is to be had. If one has to deal with a stream like the Arkansas or Red, or the larger rivers in an alluvial country, what seems best is the mattress just mentioned. It is very expensive to construct in most streams, as it must be carried to the thalweg of the stream (this is a German word for which we have no English equivalent, and means the center of the deepest thread of the stream,) and it also must be carried both above and below the points where the current strikes the bank. Unless this is done, the current will work around one end, or under the mattress and destroy it.

In 1884 the Mississippi river was attacking the Illinois shore at Eliza Point, just above Cairo, eating it away, the river having narrowed to about 700 feet, the depth at this point being 75 feet. This threatened to leave Cairo ultimately on an island. It was protected by a mattress 120 feet in width, for a distance of 4,563 feet along the bank; also by two small mattresses to strengthen some old work which had been done by a land company. This protection cost $36,010, or about $8.00 per foot of bank. The only repair work necessary at that place since the work was done has been to replace some of the riprap above low water which was damaged by ice. This work was a decided success.

On the opposite side of the river, at Bird's Point, were located the yards of the Cotton Belt and the Iron Mountain railroads. This point was threatened, and was protected at three different times, about 1888, 1897 and 1903. I could find no records of the protection of 1888 save that two coal barges were loaded with stone and sunk to divert the current. In 1897, 5,200 lineal feet of bank was riprapped at a cost of $37,028. In 1903 the so-called David Neale system was used for a distance of 4,700 feet, at a cost of $29,140. In 1904 the U. S. Engineers protected the bank with a mattress some distance above the part protected by the Neale method the year before. In 1905 all of the Neale protection was gone, and all but 400 feet of the riprap. The railroad companies lost two inclines and two yards, although part of the Cotton Belt yard was saved together with round houses, stations, etc. Some valuable farm lands and levees were also lost.

Countless proposals have been made for river control, but none to my knowledge has succeeded. One system tried out on the Missouri river cost over $2,000,000. Even this has been entirely destroyed.

The difficulty in protecting against water is the fluidity of the material we are contending with. It changes its form of attack repeatedly. A body of water fifty feet deep, moving five feet per second, has a vast momentum, and carries with it destruction. A plan which may be safe this year may not be next year, owing to a change in the direction of attack of the water. Lack of following up protection work and strengthening the weak points results in many failures.

The city of Pine Bluff was threatened in 1881 and there were all sorts of outcries. A considerable portion of the town was carried away. It was discovered that the banks could be protected by mattresses weighted with boxes filled with sand. It stopped the

wash at the time, but year by year the boxes warped, the sand filtered out, the boxes floated off at the next rise and within a few years it was necessary to protect the bank again. This time it was done by stone-capped brush dikes, set at an angle of forty degrees to the current. This protected the bank for many years, but the dikes were too close together, eddies formed below each, and in time they were destroyed. Dikes must be so close together that the next dike below will catch the eddy and break it. Some two years ago these dikes were washed out, the banks caved, seven houses were washed into the river, the court house was partly destroyed and the leading hotel threatened. The bank is now protected by fascine mattresses and is probably safe.

In the lesser matters, I presume that all of us here have had to get out of bed at night and help pile in stone to save some threatened point. It is not necessary to speak of that method; the main thing is to get there in time.

Mr. Killam:—Years ago, when I was doing contract work for the government of the Province of New Brunswick, in some places the water carried away the entire embankment, in a heavy storm. The surface was of alluvial soil with gravel underneath. About a thousand feet was washed away in one particular place, and I was asked by the engineer of the department at headquarters to repair it. I leveled off the bottom, laid a brush foundation about twenty feet wide at an angle of forty-five degrees, with the tops of the trees angling down stream, and then there was built on it a sort of timber abutment seven feet from the front and fourteen feet high. The space back of it was then filled with earth and stone, making the embankment the original width; the top surface was given a coating of heavy stone. That was some twenty-seven years ago, and there has never been a dollar expended there since. We have found in such cases that there is nothing equal to soft wood brush, such as spruce and fir, put in at an angle with the stream, and then placing stone upon it.

Where we have culverts through heavy embankments in gravel the undertow of the water at the outlet end washes under and undermines them. In such cases we have put in concrete floors which settled the difficulty. On the banks of some of the rivers at the head of the Bay of Fundy, where the marsh mud and the silt give way, (these creeks along the river are generally very crooked and the tide is very rapid,) we build piers, or jetties as they would more properly be termed, angling with the current around the curve, to break the current in that way. In some cases the jetties would be

undermined and go down but they would be built up again better than ever, and in no case did we ever fail to stop the banks from washing away by taking those precautions. The main thing is to have the foundation put down far enough to prevent washing underneath and undermining it. When the water comes in contact with these jetties it is diverted much after the fashion of earth passing over the mould board in plowing land. In ordinary cases of bank wash the brush covered with stone is effective, and it also prevents washing around piers, abutments, etc. Stone alone will not answer the purpose. Some of the jetties mentioned above, I put in myself, as long ago as 1868 or 1869, and they are still in service.

Mr. Penwell:—I want to ask Mr. Killam if he used evergreens in that work.

Mr. Killam:—Yes sir.

Mr. Penwell:—Where we cannot get evergreens would you think of using common hardwood brush?

Mr. Killam:—I think that the hardwood brush alone will not answer, but in some cases we have mixed a little hardwood brush with the evergreens and I don't know but that in some cases it is preferable to do so.

Mr. Staten:—Some may be surprised to know that slate is about as good as anything to prevent wash. There are a number of slate quarries on our road where we can procure waste and broken slate at little cost. While it would not go far toward preventing a wash in the Mississippi river, it does very well along creeks or small rivers. We simply throw it down the bank, and after a little sediment gets into it that acts as a binder and the water will never carry it away. If washing undermines it and it settles, that fact will not matter, for it will not go far. We had a great many places where the water washed away the sides of embankments, often making it quite serious, but we deposited a lot of this slate there and it put an end to the trouble. It has been there for years. Grass and weeds have grown up through it, making a perfect mesh, and it withstands the wash perfectly. We use it also around abutments and piers where it affords most excellent protection.

The President:—I would like to hear from some of these newer members. Unfortunately I do not know their names. As a rule when they get out of the convention hall they can tell us all about it, but they do not feel free in expressing themselves in the convention.

Mr. Penwell:—I would like to hear from Mr. Loftin on this subject.

Mr. Loftin:—I have nothing further to say now I believe. My work is in the secretary's hands. I will say a few words, however, concerning the work in connection with the making up of the report. The committee expected quite a good deal of outside assistance, and had the promise of it, but in the end we received very little. On that account the report is not what it should be; besides, it was sent in too late for the advance copies. The fault is probably due to my holding on to the report until the last moment, with the expectation of getting something additional, but we did not get it. I should have forwarded it earlier. I am sorry it was sent in so late.

The President:—The report is a valubale addition to that of last year. As stated by Mr. Van Auken, a good deal depends upon the character of the soil which makes up the banks and the bed of the stream.

Mr. Penwell:—My object in calling for Mr. Loftin was not in regard to his report, but I know that he has had considerable experience in connection with this subject on his line, and that is what I sought to bring out in the discussion.

The President:—Mr. Penwell called attention to the fact, Mr. Loftin, that you have had some experience in regard to embankment protection which he wanted you to relate. Was your experience fully given in the report?

Mr. Loftin:—I have not given much of my experience in this report. Most of that was given in last year's report. To devise a system that will suit conditions everywhere is impracticable. I might say that this is a poor subject to gather information on. People do not like to take hold of it. I had quite a time getting any information at all. There are many subjects where data for them are on file and accessible at all times, but washouts and the protection of embankments is something that comes to us no two times alike, and when they do come they come quickly, so that it is pretty difficult to lay down any fixed rule that will apply to even a few cases of embankment protection. That is my experience.

We have a report from the Mississippi River Commission which goes pretty well into details. It shows the process of doing this work and what it costs. This is based on a mattress 255 feet wide and 900 feet long. They had just sunk a mattress opposite Vicksburg of the same dimensions when I left to come here. Down with us washouts are a little different from the washouts up in this country. We have the Mississippi river to contend with. I have seen

the Mississippi river 75 miles wide right over the track of the Vicksburg, Shreveport & Pacific Ry., with the exception of four miles. When you get up against conditions of that kind, you have something to do.

The President:—My early experience was confined to the northern part of Wisconsin where there are no alluvial deposits but simply hard material. A few years ago, after I had been transferred to Iowa I was suddenly confronted with the threatened cutting away of a bank of the Missouri river near Sioux City, and I suggested driving some piles to protect the bank. I think I would have made a mistake if I had done so, do you not, Mr. Van Auken?

Mr. Van Auken:—I think you would. I will refer to one piece of work done on the Missouri river some time between 1878 and 1883, by the Chicago, Burlington & Quincy R. R., near Plattsmouth, Neb. They reclaimed their Plattsmouth yard from the Missouri river. As I recall it, there was a stone quarry some miles up the river that they secured. They got some scows that were fifty or sixty feet long and drove a row of piles that were slightly closer together than the length of the scows, along the outside of what they wanted to reclaim for this yard. They would load these scows with stone at the quarry and drop them down and tie them to these piles and then just throw the stone off on the inside of the scow. They built the work up in this way to a little above the surface at low water, just to such height as they could easily throw the stone off the scows, and the next high water filled the space full of silt behind those stones. They soon had it up to low-water grade. They continued to build it up and the next high water filled it up further and they merely had to build enough above that to make it safely above high water. They could not get back of the bluffs. Anybody who knows about the bluffs along the Missouri river knows what that means. I was not connected with that work, but any one who is interested can find it described in one of the numbers of Van Nostrand's Magazine, between 1879 and 1884.

The President:—I know that the Chicago & Northwestern Ry. is spending annually all the way from $50,000 to $75,000 for the work of protection along the Missouri river at Blair. Sioux City was never threatened until about four years ago. I mentioned the beginning of my experience in Iowa, but before the work was completed I was relieved of that territory, to my great regret, and my successor completed the work. There has been a great deal of that kind of work done also at Pierre, So. Dak., where the new bridge

was built across the river by the Northwestern on the Pierre and Rapid City line.

I have taken enough interest in that work at Sioux City to know that it was entirely successful. The railroad was constructed in a side-hill cut, where the hill dropped closely to the river, and it began to eat out the bank and was threatening the main line. Action was taken right away, and there hasn't been any trouble since.

If there is any one else who would like to speak on the subject, we will be glad to hear from him. We have brought out some information, as a result of the discussion of this report, that is of considerable interest.

Mr. Sattley:—I would like to ask if the report gives the price of doing work, per running foot or otherwise?

Mr. Loftin:—Yes, I have given prices for all of this work.

I failed to state that down in our country we do not have stone for emergency protection work, as they have in this part of the country. About the only thing we have down there for protecting embankments along the track is slag, which we get from Alabama, and that is some distance away. While it is not very large in size, it protects embankments pretty well when applied six inches or more in thickness. Bermuda grass soon takes root and grows right through it. Bermuda grass also grows through cinders, and in fact will grow anywhere, almost, and forms a good mat and makes a good protection,—better than anyone would at first suppose.

Mr. Van Auken:—(Replying to question of Mr. Sattley.) That is a question you cannot answer for all places. The cost of the mattress is dependent upon the cost of the brush and the stone, which varies greatly, according to the supply and the accessibility of the same. Then the width of the stream determines the width of the mattress. As I before stated, one must go from the low-water edge of the bank to the central thread of the deepest part of the river. The Missouri river, at Bismarck, is a very different stream from the same river at Kansas City, and the latter is very different from the Mississippi at Vicksburg. Mr. Loftin's report gives the price per lineal foot at the latter place. At Cairo the price might be half that, and at Sioux City one-fourth. Then, when there is much work being done, there may be a shortage of brush. The Mississippi River Commission has made some mattresses by using cypress boards. In general, the cost will depend upon the cost of stone, cost of brush and size of mat.

Mr. Sattley:—Is not this work done by contract, sometimes?

Mr. Van Auken:—Yes sir.

Mr. Sattley:—Are there any statistics on that question? If so where can they be found?

Mr. Van Auken:—The reports of the Mississippi River Commission give each year the cost of such work done under the supervision of that organization. The U. S. engineer officers in charge of the Mississippi river, from St. Paul to Grafton, and from Grafton to Cairo, and those in charge of the Missouri each give such costs. The Chicago & Alton Ry. had some work done near its bridge across the Missouri, and the costs of that are given in a report made by W. R. DeWitt, in Engineering News, in 1904. Camp's book on track goes into the details of such work, including the division of the labor, and the cost.

Mr. Loftin:—Getting back to the fascine mattress; I have given the cost of brush, the specifications for it, size, kind and number of cables with which it is woven and the spacing of them. This kind of river protection deals only indirectly with the subject and we did not go into it very far, for we were not certain whether or not it would be acceptable as a part of the report.

River protection is a large undertaking and a pretty big outfit is necessary for that kind of work. A government plant for such work I should say would cost anywhere from $200,000 to $350,000. The cost of the upkeep of such a plant would also be considerable, of course. We have tracks along the banks of the Mississippi river where there is an alluvial soil which may be 100 feet deep, I am not sure about that, but anyway, when it starts to wash we have to get after it to check it. At Vicksburg as I stated in the report of last year, the river changed its channel in 1876, so that it left Vicksburg entirely away from the river, and the government has spent a great sum of money, I don't know just how much, but a great deal of money, in changing the direction of the Yazoo river to bring it back in front of Vicksburg in order to restore navigation and put the city on the water front again. If I could have found Mr. Van Auken while I was engaged in the report I would have had a good, strong supporter.

The President:—It is a good thing that we have found him here.

Mr. Loftin:—Yes, I am glad to admit it. I think I will have to hunt him up and play neighbors with him.

The President:—Mr. Van Auken, I have in my mind that the Burlington Railroad has a special department in charge of river protection.

Mr. Van Auken:—During the time Mr. Byers was Chief En-

gineer of Maintenance of Way of the Missouri Pacific Ry., he had an officer called " Engineer of River Protection."

The President:—That must have been it.

Mr. Van Auken:—The Chicago & Alton R. R. protected a considerable stretch up the Missouri river with these fascine mattresses, and after they had done that they had another stretch threatened; but owing to the great cost of mattresses they protected that with spur dikes. The dikes were built by driving in piling and then fastening a rail to it. I think it was bolted or wired to it. There were two rows of piles and these rails were bolted to them and they were braced across between the rows of piling. Then at the upper edge there were saplings and pieces of two by fours, I think, spiked up and down to these rails that I have mentioned. This ran nearly at right angles to the bank, out into the stream. This arrangement created a bar at these points, as it is bound to do if the dikes are built close enough together. They built a bar outside of the bank, and by that protected the bank. The trouble with these dikes is that they are short lived; they require constant attention every year, and probably have to be rebuilt once in seven or eight years; but they are much cheaper in first cost, than the fascine mattresses. I wish to say that where the Rock Island crosses the river they have resorted to the same manner of protecting their banks, by building dikes and filling them in with stone. Of course the current is not very swift there, but these banks fill up and make land themselves. The scheme works all right where there is a solid bottom; but if one ever tried that on the Mississippi river he would find that the stone would disappear and have but little effect. At Bird's Point I took some soundings three years after some such work had been done and while our line was 75 feet long the lead disclosed no signs of stone. Stone simply will have no effect in such places.

The President:—Gentlemen what will you do with the report?

Mr. J. H. Markley:—I move that the report be received and the committee discharged with the thanks of the association.

The motion was seconded and carried.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891.	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892.	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Col.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis...	H. M. Hall......	J. E. Wallace....	Geo. W. Andrews.
1st. V.-Pres. .	H. M. Hall.....	J. E. Wallace....	Geo. W. Andrews..	W. A. McGonagle.
2nd. V.-Pres.	J. B. Mitchell..	G. W. Hinman..	W. A. McGonagle.	L. K. Spafford.
3rd. V.-Pres.	James Stannard.	N. W. Thompson	L. K. Spafford....	James Stannard.
4th. V.-Pres. .	G. W. Hinman..	C. E. Fuller....	E. D. Hines......	Walter G. Berg.
Secretary	C. W. Gooch...	S. F. Patterson..	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid.	George M. Reid..	George M. Reid..	George M. Reid.
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	G. W. Turner...	Floyd Ingram...	James H. Travis ..	J. L. White.
	J. E. Wallace...	A. S. Markley...	J. H. Cummin	A. Shane.

	1895-6.	1896-7.	1897-8.	1898-9.
President	W. A. McGonagle	James Stannard..	Walter G. Berg....	J. H. Cummin.
1st. V.-Pres. .	L. K. Spafford.	Walter G. Berg..	J. H. Cummin....	A. S. Markley.
2nd. V.-Pres.	James Stannard.	J. H. Cummin...	A. S. Markley....	C. C. Mallard.
3rd. V.-Pres.	Walter G. Berg.	A. S. Markley...	G. W. Hinman....	W. A. Rogers.
4th. V.-Pres. .	J. H. Cummin.	R. M. Peck....	C. C. Mallard.....	J. M. Staten.
Secretary	S. F. Patterson.	S. F. Patterson..	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid.	N. W. Thompson	N. W. Thompson..	N. W. Thompson.
Executive Members .	R. M. Peck....	W. O. Eggleston	G. J. Bishop......	Wm. S. Danes.
	J. L. White...	W. M. Noon....	C. P. Austin......	J. H. Markley.
	A. Shane	J. M. Staten....	M. Riney	W. O. Eggleston.
	A. S. Markley..	G. J. Bishop.....	Wm. S. Danes....	R. L. Heflin.
	W. M. Noon...	C. P. Austin....	J. H. Markley....	F. W. Tanner.
	J. M. Staten...	M. Riney	W. O. Eggleston..	A. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President	Aaron S. Markley	W. A. Rogers....	W. S. Danes.....	B. F. Pickering.
1st. V.-Pres. .	W. A. Rogers...	W. S. Danes.....	B. F. Pickering..	C. C. Mallard.
2nd. V.-Pres.	J. M. Staten....	B. F. Pickering..	A. Shane	A. Shane.
3rd. V.-Pres.	Wm. S. Danes...	A. Shane........	A. Zimmerman ..	A. Zimmerman.
4th. V.-Pres. .	B. F. Pickering..	A. Zimmerman ..	C. C. Mallard....	A. Montzheimer.
Secretary	S. F. Patterson..	S. F. Patterson..	S. F. Patterson..	S. F. Patterson.
Treasurer	N. W. Thompson	N. W. Thompson.	N. W. Thompson.	N. W. Thompson.
Executive Members .	T. M. Strain....	T. M. Strain.....	A. Montzheimer..	W. E. Smith.
	R. L. Heflin....	H. D. Cleaveland.	W. E. Smith.....	A. W. Merrick.
	F. W. Tanner...	F. W. Tanner...	A. W. Merrick...	C. P. Austin.
	A. Zimmerman...	A. Montzheimer.	C. P. Austin.....	C. A. Lichty.
	H. D. Cleaveland	W. E. Smith....	C. A. Lichty.....	W. O. Eggleston.
	A. Montzheimer.	A. W. Merrick...	W. O. Eggleston.	J. H. Markley.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President	A. Montzheimer..	C. A. Lichty...	J. B. Sheldon....	J. H. Markley.
1st. V.-Pres. .	A. Shane	J. B. Sheldon..	J. H. Markley....	R. H. Reid.
2nd. V.-Pres.	C. A. Lichty....	J. H. Markley..	R. H. Reid.......	J. P. Canty.
3rd. V.-Pres.	J. B. Sheldon...	R. H. Reid.....	R. C. Sattley....	H. Rettinghouse.
4th. V.-Pres. .	J. H. Markley...	R. C. Sattley...	J. P. Canty......	F. E. Schall.
Secretary	S. F. Patterson..	S. F. Patterson..	S. F. Patterson..	S. F. Patterson.
Treasurer	C. P. Austin....	C. P. Austin....	C. P. Austin.....	C. P. Austin.
Executive Members .	R. H. Reid......	W. O. Eggleston	H. Rettinghouse .	W. O. Eggleston.
	W. O. Eggleston	A. E. Killam....	A. E. Killam.....	A. E. Killam.
	A. E. Killam....	H. Rettinghouse.	J. S. Lemond.....	J. S. Lemond.
	R. C. Sattley....	J. S. Lemond....	C. W. Richey....	C. W. Richey.
	H. Rettinghouse..	W. H. Finley..	H. H. Eggleston.	H. H. Eggleston.
	J. S. Lemond....	C. W. Richey...	F. E. Schall.....	B. J. Sweatt.

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid......	J. P. Canty	J. S. Lemond....	H. Rettinghouse
1st. V.-Pres. .	J. P. Canty.....	H. Rettinghouse..	H. Rettinghouse..	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse..	F. E. Schall.....	F. E. Schall.....	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J. S. Lemond....	A. E. Killam...	J. N. Penwell
4th. V.-Pres. .	W. O. Eggleston.	A. E. Killam....	J. N. Penwell..	L. D. Hadwen ..
Secretary	S. F. Patterson..	S. F. Patterson..	C. A. Lichty....	C. A. Lichty
Treasurer	C. P. Austin....	C. P. Austin....	J. P. Canty.....	J. P. Canty
Executive Members .	A. E. Killam....	J. N. Penwell....	W. Beahan	T. J. Fullem
	J. S Lemond.....	Willard Beahan ..	F. B. Scheetz .	G. Aldrich
	C. W. Richey....	F. B. Scheetz...	L. D. Hadwen ..	P. Swenson
	T. S. Leake......	W. H. Finley...	T. J. Fullem....	G. W. Rear
	W. H. Finley....	L. D. Hadwen ..	G. Aldrich......	W. O. Eggleston.
	J. N. Penwell....	T. J. Fullem....	P. Swenson.....	W. F. Steffens

	1911-1912.			
President	F. E. Schall			
1st. V.-Pres. .	A. E. Killam ...			
2nd. V.-Pres.	J. N. Penwell ...			
3rd. V.-Pres.	L. D. Hadwen ..			
4th. V.-Pres. .	T. J. Fullem			
Secretary	C. A. Lichty			
Treasurer	J. P. Canty			
Executive Members .	G. Aldrich			
	P. Swenson			
	G. W. Rear			
	W. F. Steffens ..			
	E. B. Ashby			
	W. O. Eggleston			

CONSTITUTION

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the principles, design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussion of the experience of its members and others, and to provide a means of exchange of ideas, so that bridge and building practice may be systematized and improved.

SECT. 2. The association shall neither endorse nor recommend any particular patents, materials or supplies, but individual opinions of members may be expressed and appear in the proceedings.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall consist of two classes, active and life members.

SECT. 2. A person who is actively engaged in railway service in a responsible position, in charge of work connected with the construction or maintenance of railway bridges and buildings or other structures, or a professor of engineering, government timber expert, or railroad architect shall be eligible for active membership upon application to the secretary, and the payment of three dollars membership fee, and two dollars for one year's dues.

SECT. 3. Any member elected a life member of this association shall have all the privileges of an active member, but shall not be required to pay annual dues. To be elected a life member he must have been a member of the association at least five years and before being elected must have been pensioned by the railway company for which he worked or shall have retired from active railway service.

SECT. 4. Any member guilty of dishonorable conduct, or conduct unbecoming a railroad official and member of this association, or who shall refuse to obey the chairman, or rules, may be expelled by a two-thirds vote of the members present.

SECT. 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members.

SECT. 2. The executive members, together with the president, vice-presidents, secretary and treasurer, shall constitute the executive committee.

SECT. 3. Past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past-presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECT. 4. Vacancies in any office for the unexpired term shall be filled by the executive committee without unnecessary delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings, make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasurer's hands not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECT. 2. Two thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECT. 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. The officers, excepting as otherwise provided, shall be elected at the regular meeting of the association, held on the third Tuesday in October of each year, and the election shall not be postponed except by unanimous consent.

SECT. 2. The president and treasurer shall be elected by ballot by a majority of votes cast, and shall hold office for one year or until successors are elected. No member in arrears shall be eligible for office, and the president shall not be eligible for reelection.

Vice-Presidents and Executive Members.

SECT. 3. The vice-presidents shall hold office for one year and executive members for two years; four vice-presidents and three executive members to be elected each year; all officers herein named to hold office until successors are chosen.

SECT. 4. In the election of vice-presidents, each one shall be elected by a majority vote. Executive members shall be elected in the same way, all voting to be by written ballots.

Secretary.

SECT. 5. A secretary shall be elected by a majority of the votes of the members present at the annual meeting. The term of office of the secretary shall be for one year, unless terminated sooner by action of the executive committee, two thirds of whom may remove the secretary at any time. His compensation shall be fixed by a majority of the executive committee. The secretary shall also be secretary of the executive committee.

Treasurer.

SECT. 6. The treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

COMMITTEES.

Nominating Committee.

SECTION 1. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year. They shall prepare a list of names of nominees for officers to be voted on at the next annual convention, agreeable to Article VI. of this constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making nominations.

Auditing Committee.

SECT. 2. At the first session of each annual meeting there shall be appointed by the president an auditing committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and treasurer and certify as to the correctness of their accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

Committee on Subjects for Discussion.

SECT. 3. At the annual meeting there shall be appointed, by the president, a committee, whose duty it shall be to prepare and report subjects for investigation and discussion at the next annual meeting. It shall be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall decide whether such questions are suitable ones for discussion, and if approved, report them to the association.

Committees on Investigation.

SECT. 4. When the committee on subjects has reported and the association approved of the same, the president shall appoint special committees to investigate and report on said subjects and he may appoint a special committee to investigate and report on any subject of which a majority of members present may approve.

Publication Committee.

SECT. 5. After each annual meeting the executive committee shall appoint a publication committee of three active members whose duty it shall be to supervise the publication of the proceedings. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year. The publication committee will report to the president and perform their duties under his supervision.

ARTICLE VIII.

ANNUAL DUES.

SECTION 1. Every active member shall pay to the secretary three dollars membership fee and shall also pay two dollars per year in advance to defray the necessary expenses of the association. No member being one year in arrears for dues shall be entitled to vote at any election, and any member one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE IX.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two thirds vote of members present, provided that a written notice of the proposed amendment, or amendments, has been given at least sixty days previous to said regular meeting.

BY-LAWS

TIME OF MEETING.

1. The regular meeting of this association shall be held annually on the third Tuesday in October.

HOUR OF MEETING.

2. The regular hour of meeting shall be at 10 o'clock a. m., unless changed by order of the presiding officer.

PLACE OF MEETING.

3. The cities or places for holding the annual convention may be proposed at any regular meeting of the association before the final adjournment. The places proposed shall be submitted to a ballot vote of the members of the association, the city or place receiving a majority of all the votes cast to be declared the place of the next annual meeting; but if no place received a majority of all votes, then the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

ORDER OF BUSINESS.

5. 1st—Calling of roll.
2nd—Reading minutes of last meeting.
3rd—Admission of new members.
4th—President's address.
5th—Reports of secretary and treasurer.
6th—Payment of annual dues.
7th—Appointment of committees.
8th—Reports of committees.
9th—Unfinished business.
10th—New business.
11th—Reading and discussion of questions propounded by members.
12th—Miscellaneous business.
13th—Election of officers.
14th—Adjournment.

(Report of nominating committee to be read at first session of second day.)

DUTIES OF OFFICERS.

6. The president shall have general supervision of the affairs of the association. He shall preside at all meetings of the asso-

ciation, and of the executive committee, at which he may be present; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall, with the secretary, sign all contracts or other written obligations of the association which have been approved by the executive committee.

At the annual meeting the president shall present a report containing a statement of the general condition of the association, and an address.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president, and discharge his duties in case of a vacancy in his office.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; collect all moneys due the association, and pay the same over to the treasurer and take his receipt therefor, and to perform such other duties as the association may require.

9. The treasurer shall receive all moneys and deposit the same in the name of the association and shall receipt to the secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee.

DECISIONS.

10. The votes of a majority of members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

11. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS

Aagaard, P., Supvr. B. and B., I. C. R. R., Chicago.
Aldrich, Grosvenor, Supvr. B. & B., N. Y., N. H. & H. R. R., Boston,
Alexander, W. E., Supt. of Bridges, B. & A. R. R., Houlton, Me.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Amos, A., M. St. P. & S. Ste. M. Ry., Minneapolis, Minn.
Anderson, August, Gen'l For. B. and B., L. S. & I. Ry., Marquette, Mich.
Anderson, L. J., For. B. and B., C. & N. W. Ry., Escanaba, Mich.
Andrews, G. W., Insp. Maint. B. & O. R. R., Baltimore, Md.
Andrews, O. H., Supt. B. and B., St. J. & G. I. Ry., St. Joseph, Mo.
Arey, R. J., Pres. Grand Canyon L. & P. Co., Williams, Ariz.
Arnold, F. J., Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
Ashby, E. B., Chief Engr., L. V. R. R., New York City.
Astrue, C. J., Asst. Engr., Sou. Pac. Co., Oakland Pier, Cal.
Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.
Austin, C. P., 107 Park St., Medford, Mass.

Bailey, F. W., Contractor, 400 No. Pleasant Ave., Independence, Mo.
Bailey, S. D., Div. For. of Buildings, M. C. R. R., Detroit, Mich.
Ball, E. E., Engr. Const., A. T. & S. F. Ry., Winslow, Ariz.
Ballenger, D. A., Roadmaster, Southern Ry., Greenville, S. C.
Barker, W. M., Br. For. S. A. L. Ry., Scotia, S. C.
Barnes, O. F., Div. Engr., Erie R. R., Susquehanna, Pa.
Barrett, E. K., Supvr. B. and B., F. E. C. Ry., St. Augustine, Fla.
Barrett, J. E., Supt. of Track, B. and B., L. & H. R. Ry., Warwick, N. Y.
Bartles, F. R., Trainmaster, N. P. Ry., Pasco, Wash.
Barton, M. M., Master Carp., P. R. R., West Philadelphia, Pa.
Bates, Onward, Civil Engineer, McCormick Bldg., Chicago.
Battey, C. C., Supvr. B. and B., B. & M. R. R., Concord, N. H.
Beahan, Willard, Asst. Engr., L. S. & M. S. Ry., Cleveland, Ohio.
Beal, F. D., 404 Central Bldg., Seattle, Wash.
Bean, C. C., 243 Benton St., Freeport, Ill.
Beard, A. H., For. Carp., P. & R. Ry., Reading, Pa.
Beckman, B. F., Supt. F. S. & W. R. R., Fort Smith, Ark.
Beeson, R. W., Div. For. B. and B., C. & S. Ry., Trinidad, Colo.
Bender, Henry, For. B. & B., C. & N. W. Ry., Eagle Grove, Ia.
Bennett, A. G., Asst. Engr., C. M. & St. P. Ry., Minneapolis, Minn.
Bentele, Hans, Asst. Ch. Engr., Nat. Rys. of Mex., Mexico City, Mex.
Berry, J. S., Supvr. B. and B., S. L. S. W. Ry., St. Louis, Mo.
Bibb, J. M., Supvr. B. and B., L. & N. R. R., Birmingham, Ala.
Bigelow, F. M., Supv. B. & B., S. P. L. A. & S. L. R. R., Salt Lake City.
Bishop, G. J., Timber Insp., S. A. & A. P. Ry., Yoakum, Texas.
Bishop, McClellan, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla.
Biss, C. H., Engr., New Zealand Govt. Rys., Christchurch, N. Z.
Black, J. D., Supvr. B. and B., P. M. R. R., Saginaw, Mich.
Blackwell, J. H., Roadmaster, Sou. Ry., Charleston, S. C.
Bowers, S. C., Mast. Carp. of Brdgs., P. C. C. & St. L. Ry., Steubenville, O.
Bowers, Stanton, Mast. Carp., P. C. C. & St. L. Ry., Bradford, O.

Bowman, A. L., Cons. Engr., Dept. of Bridges, New York City.
Boyd, G. E., Supt. B. & B., D. L. & W. R. R., Scranton, Pa.
Bratten, T. W., Supvr., B. and B., S. P. Co., Oakland Pier, Cal.
Briggs, B. A., Supt. Streets, Colorado Springs, Colo.
Brown, Alf, Supt. B. & B., St. L. R. M. & P. R. R., Raton, N. M.
Browne, J. B., Gen'l For. B. and B., K. C. C. & S. Ry., Clinton, Mo.
Browne, J. S., Div. Engr., N. Y. N. H. & H. R. R., Providence, R. I.
Bruce, R. J., Supt. Bldgs., M. P. Ry., St. Louis, Mo.
Bulger, Hugh, For. B. & B., Sou. Pac. Co., Oakland Pier, Cal.
Burke, Daniel, Supvr. B. and B., Sou. Pac. Co., Tucson, Ariz.
Burgess, W. H., Supvr. B. & B., Sou. Pac. Co., Stockton, Cal.
Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.
Burpee, T. C., Engr. M. of W., Intercolonial Ry., Moncton, N. B.
Burrell, F. L., Gen'l For. B. and B., C. & N. W. Ry., Fremont, Neb.

Cable, C. C., C. E., Marcellus, Ky.
Cahill, E., Genl. For. B. & B., D. L. & W. R. R., Binghamton, N. Y.
Cahill, M. F., Contractor, 1641 Market St., Jacksonville, Fla.
Cahill, P. W., For. Carp., S. A. L. Ry., Fernandina, Fla.
Caldwell, J. M., Insp. B. and B., C. I. & L. Ry., Lafayette, Ind.
Caldwell, J. T., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Canty, J. P., Supt. B. and B., B. & M. R. R., Boston, Mass.
Cardwell, W. M., Mast. Carp. W. T. Co., Washington, D. C.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., Supt. Const., Southern Ry., Princeton, Ind.
Carter, E. M., Supvr. B. and B., T. C. R. R., Nashville, Tenn.
Case, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
Catchot, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
Christy, B. B., Br. For., S. A. L. Ry., Tallahassee, Fla.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth, Minn.
Clark, W. M., Mast. Carp., B. & O. R. R., Pittsburgh, Pa.
Cleaveland, H. D., Mast. Carp., B. & L. E. R. R., Greenville, Pa.
Clopton, A. S., Supt. B. & B., M. K. & T. Ry., Parsons, Kans.
Cole, J. E., Gen'l For. B. and B., C. V. R. R., St. Albans, Vt.
Colwell, A. J., Norfolk, Neb.
Conkling, Wm. A., Supvr. B. and B., U. P. R. R., Omaha.
Cookson, D. M., Asst. Engr., Burma Ry. Extn. Kalaw, Burma, India.
Coombs, R. D., Const. Engr., 1112 Broadway, New York City.
Corbin, W. S., For. B. and B., Sou. Pac. Co., Los Angeles.
Costolo, J. A., Insp. Transfer Boats, M. P. Ry., St. Louis, Mo.
Cullen, J. F., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cummin, Joseph H., Bay Shore, N. Y.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curtin, William, Contractor, Govan, Saskatchewan.

Dale, Wm. C., For. W. S., O. S. L. R. R., Salt Lake City.
Dalstrom, O. F., Ch. Dftsman. Br. Dept., C. & N. W. Ry., Chicago.
Danes, W. S., Engr. M. of W., Wabash R. R., Peru, Ind.
Davis, C. H., Civil Engineer, South Yarmouth, Mass.
Dawley, W. S., Ch. Engr., Y. S. & T. Ry., Yunnan Fu, China.
De Capito, T. F., Gen'l For. B. and B., Q. O. & K. C. R. R., Milan, Mo.
Decker, H. H., Div. Engr., C. & N. W. Ry., Winona, Minn.
Detter, G. W., Dallas, N. C.
Develin, R. G., Asst. Engr. M. of W., P. R. R., Philadelphia, Pa.
Dickson, Geo., For. Brdgs., Sou. Pac. Co., Oakland, Cal.
Dodd, A. M., Brazil Ry., Sao Paulo, Brazil, S. Am.
Dolan, E. M., Bldg. Inspr., Mo. Pac. Ry. Sys., St. Louis.
Donaldson, Claud, For. B. & B., C. Vt. R. R., Waterbury, Vt.
Douglass, H. S., Supvr. B. & B., Sou. Ry., Charleston, S. C.
Douglas, W. J., C. E., 60 Wall St., New York City.
Drake, F. M., Dist. Engr., Sou. Pac. Co., San Francisco, Cal.

Draper, F. O., Supt. of Bridges, I. C. R. R., Chicago.
Drum, H. R., Chief Carp., C. M. & St. P. Ry., Chamberlain, S. D.
Dupree, James, For. W. S., C. T. H. & S. E. Ry., Crete, Ill.
Durfee, T. H., For. B. and B., C. & N. W. Ry., Huron, S. D.

Edinger, F. S., C. E., 334 Crosby Bldg., San Francisco.
Eggers, C. H., Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
Eggleston, H. H., Asst. Supvr. B. & B., B. & O. C. T. R. R., Chicago.
Eggleston, W. O., Insp. of Bridges, Erie R. R., Huntington, Ind.
Elliott, R. O., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Elwell, H. A., Supvr. B. & B., C. G. W. Ry., Clarion, Ia.
Ettinger, C., Gen. Ptr. For., I. C. R. R., Chicago.
Ewart, John, Spvr. Water Service, B. & M. R. R., Boston, Mass.

Fake, C. H., Ch. Engr., M. R. and B. T. R. R., Bonne Terre, Mo.
Fellows, C. W., For. W. S., C. & S. Ry., Denver, Colo.
Fenney, George, Mast. Carp., C. B. & Q. R. R., McCook, Neb.
Ferdina, A. H., For. B. & B., St. L. I. M. & S. Ry., St. Louis.
Ferris, B. F., For. B. and B., Sou. Pac. Co., Los Angeles.
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Stanley, E. A., Supvr. B. & B., Mo. Pac. Ry., St. Louis.
Staten, J. M., Gen'l Bridge Insp., C. & O. Ry., Richmond, Va.
Steffens, W. F., Engr. of Structures, B. & A. R. R., Boston.
Stelle, C. A., Div. Engr., W. & L. E. R. R., Canton, O.
Stern, I. F., C. E., Old Colony Bldg., Chicago.
Storck, E. G., Mast. Carp., P. & R. Ry., Philadelphia, Pa.
Strouse, W. F., Asst. Engr., B. & O. R. R., 400 Forest Road, Baltimore.
Stuart, T. J., Supvr. B. and B., W. Pac. Ry., Elko, Nev.
Sullivan, William, Care Div. Engr., Mo. Pac. Ry., Kansas City, Mo.
Swain, G. F., Prof. C. E., Harvard University, Cambridge, Mass.
Swallow, W. A., Ch. Engr., Ga. & Fla. Ry., Augusta, Ga.
Swartz, A., Div. Engr., Erie R. R., Huntington, Ind.
Swartz, H. C., Master B. & B., G. T. R., St. Thomas, Ont.
Sweeney, Wm., For. B. and B., C. & N. W. Ry., Green Bay, Wis.
Swenson, P., Supt. B. and B., M. St. P. & S. Ste. M. Ry., Minneapolis.

Talbott, J. L., Gen'l For. B. and B., A. T. & S. F. Ry., Pueblo, Col.
Tanner, F. W., Insp. M. of W., Mo. Pac. Ry., St. Louis, Mo
Tanner, S. C., Mast. Carp., B. & O. R. R., Baltimore, Md.
Taylor, D. B., Mast. Carp., B. & O. R. R., Garrett, Ind.
Taylor, Herbert, Supvr. B. and B., D. & R. G. R. R., Alamosa, Colo.
Taylor, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
Taylor, J. C., Supvr. B. and B., N. P. Ry., Glendive, Mont.
Taylor, J. J., Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
Teaford, J. B., Supvr. B. & B., Sou. Ry., Princeton, Ind.
Templin, E. E., For. Carp., P. & R. Ry., Pottsville, Pa.
Thomas, C. E., Gen'l For. W. W., I. C. R. R., Chicago.
Thompson, C. S., Supt. B. and B., D. & R. G. R. R., Denver.
Thompson, C., Asst. Supvr. B. and B., E. J. & E. Ry., Gary, Ind.
Thompson, H. C., Div. Engr., N. Y. C. & H. R. R. R., Weehawken, N. J.
Thompson, F. L., Engr. B. & B., I. C. R. R., Chicago.
Thorn, J. O., Room 404 Kiam Bldg., Houston, Tex.
Toohey, J. E., Gen'l For. B. and B., P. M. R. R., Grand Rapids, Mich.
Trapnell, William, Ch. Engr., Hampshire Southern R. R., Romney, W. Va.
Travis, J. E., Br. For., I. C. R. R., Carbondale, Ill.
Travis, J. H., Insp. Iron Br. Erec., C. & N. W. Ry., Chicago.

Travis, O. J., Box 11, Lowell, Wash.
Trippe, H. M., Res. Engr., C. & N. W. Ry., Chicago.
Troup, G. A., Engr., Govt. Rys., Wellington, N. Z.

Van Auken, A. M., Ch. Engr., M. D. & G. R. R., Nashville, Ark.
Vance W. H., Engr. M. of W., La. & Ark. Ry., Stamps, Ark.
Vandegrift, C. W., C. & O. Ry., Ronceverte, W. Va.
Vaughan, James, Supvr. B. and B., D. & R. G. R. R., Salida, Colo.
Vest, W. E., Supt. City W. W., Charlotte, N. C.
Vincent, E. J., For. B. & B., Sou. Pac. Co., Los Angeles.

Wackerle, L. J., Insp., M. of W., M. P. Ry., Kansas City, Mo.
Waits, A. L., For. B. and B., St. L. I. M. & S. Ry., Argenta, Ark.
Walker, I. O., Asst. Engr., N. C. & St. L. Ry., Paducah, Ky.
Wallenfelsz, J., Mast. Carp., Pa. Lines W., Cambridge, O.
Walther, C. H., Supvr. B. & B., Mo. Pac. Ry., Poplar Bluff, Mo.
Warcup, C. F., For. W. S., G. T. R., St. Thomas, Ont.
Ware, B. C., Mast. Carp., C. R. I. & P. Ry., Dalhart, Tex.
Ware, Norton, Br. Engr., W. Pac. Ry., San Francisco.
Warne, C. C., Asst. Engr., N. Y. C. & H. R. R. R., New York City.
Watson, P. N., Supvr. B. and B., Maine Central R. R., Brunswick, Me.
Wehlen, Charles, Br. Inspr., L. I. R. R., Jamaica, N. Y.
Weise, F. E., Chief Clerk, Eng. Dept., C. M. & St. P. Ry., Chicago.
Weldon, A., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Welker, G. W., Supvr. B. and B., Southern Ry., Alexandria, Va.
Wells, J. M., A. T. & S. F. Ry., Chillicothe, Ill.
Wenner, E. R., Supvr. B. and B., L. V. R. R., Ashley, Pa.
Wheaton, L. H., Div. Engr., G. T. P. Ry., Moncton, N. B.
White, I. F., Div. Engr., C. H. & D. Ry., Indianapolis, Ind.
White, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
Whiting, B. F., Supvr. B. & B., M. & O. R. R., Murphysboro, Ill.
Wicks, Warren, Gen'l For. L. I. R. R., Amityville, N. Y.
Wiley, J. G., Supvr. B. and B., Sou. Pac. Co., Dunsmuir, Cal.
Wilkinson, J. M., For. B. and B., C. N. R. R., Van Wert, Ohio.
Wilkinson, W. H., Bridge Insp., Erie R. R., Elmira, N. Y.
Williams, Arthur, Engr., W. & M. Ry., Wellington, N. Z.
Williams, J. C., Supvr. B. and B., A. & W. P. Ry., Opelika, Ala.
Williams, M. R., Gen. For. B. & B., A. T. & S. F. Ry., Las Vegas, N. M.
Wilson, E. E., Supvr. of Bridges, N. Y. C. & H. R. R. R., New York City, (81 E. 125th St.).
Wilson, Jas. A., Br. For., S. A. L. Ry., Woodbine, Ga.
Wilson, M. M. Div. Br. Inspr., Sou. Pac. Co., Los Angeles
Wilson, W. W., Div. Engr., G. C. & S. F. Ry., Galveston, Tex.
Winter, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
Wise, E. F., 207 Clay St., Waterloo, Iowa.
Witt, C. C., Engr. Kans. Pub. Utilities Com., Topeka, Kans.
Wolf, A. A., Dist. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Wood, J. P., For. B. & B., P. M. R. R., Edmore, Mich.
Wood, J. W., Gen'l For. B. and B., A. T. & S. F. Ry., Needles, Cal.
Wood, W. E., Dist. Engr., C. M. & St. P. Ry., Chicago.
Wright, C. W., Mast. Carp., L. I. R. R., Jamaica, N. Y.
Wright, G. A., Ill. Traction System, Decatur, Ill.

Yappen, Adolph, Dist. Carp., C. M. & St. P. Ry., Chicago.
Yereance, W. B., Cons. Engr., 128 Broadway, New York City.
Young, R. C., Chief Engr., L. S. & I. Ry., Marquette, Mich.

Zinck, K. J. C., C. E., Box 2243, Winnipeg, Man.
Zinsmeister, E. C., Mast. Carp., B. & O. R. R., Zanesville, O.
Zook, D. C., Mast. Carp., Pa. Lines W. of Pitts., Ft. Wayne, Ind.

LIFE MEMBERS.

Amos, Alexander, Soo Line, Minneapolis, Minn.
Austin, C. P., 107 Park St., Medford, Mass.
Carpenter, J. T., Sou. Ry., Princeton, Ind.
Cummin, Jos. H., Bay Shore, N. Y.
Forbes, Jno., 45 Victoria Road, Halifax, N. S.
Foreman, John, P. & R. Ry., Pottstown, Pa.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Green, E. H. R., Texas Midland R. R., Terrell, Tex.
Hubbard, A. B., B. & M. R. R., Boston, Mass.
McIntyre, James, Miami, Fla.
Patterson, S. F., B. & M. R. R., Concord, N. H.
Perry, W. W., P. & R. Ry., Williamsport, Pa.
Phillips, H. W., So. Braintree, Mass.
Porter, L. H., Box 35, Andover, Conn.
Stannard, Jas., 1602 Broadway, Kansas City, Mo.
Travis, O. J., Box 11, Lowell, Wash.
Vandegrift, C. W., C. & O. Ry., Ronceverte, W. Va.
Wells, J. M., Chillicothe, Ill.
Wise, E. F., 207 Clay St., Waterloo, Ia.

DECEASED MEMBERS.

Berg, Walter G.
Blair, J. A.
Brady, James.
Carr, Charles.
Causey, T. A.
Crane, Henry
DeMars, James.
Dunlap, H.
Fletcher, H. W.
Fuller, C. E.
Gilbert, J. D.
Gilchrist, E. M.
Graham, T. B.
Hall, H. M.
Heflin, R. L.
Henson, H. M.
Hinman, G. W.
Humphreys, Thos.
Isadell, L. S.
Johnson, J. E.
Keen, Wm. H.
Lantry, J. F.
Large, C. M.
Lovett, J. W.
Markley, Abel S.
McCormack, J. W.
McGehee, G. W.
Mellor, W. J.
Millner, S. S.
Mitchell, J. B.
Mitchell, W. B.
Morgan, T. H.
Morrill, H. P.
Peck, R. M.
Reid, G. M.
Renton, Wm.
Reynolds, E. F.
Robertson, Daniel
Schwartz, J. C.
Spafford, L. K.
Spangler, J. A.
Spaulding, E. C.
Spencer, C. F.
Taylor, J. W.
Thompson, N. W.
Tozzer, Wm. S.
Trautman, J. J.
Van Der Hoek, J.
Wallace, I. E.
Walden, W. D.
Welch, E. T.
Wood, W. B.
Worden, C. G.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Algoma Central & Hudson Bay Ry.	1	116
R. S. McCormick, Sault Ste. Marie, Ont.		
Arizona Eastern R. R.	1	355
C. C. Mallard, Globe, Ariz.		
Atchison, Topeka & Santa Fé Ry.	4	5,604
E. McCann, Wellington, Kan.		
John L. Talbott, Pueblo, Col.		
J. M. Wells, Chillicothe, Ill.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	5	2,022
E. E. Ball, Winslow, Ariz.		
J. F. Parker, San Bernardino, Cal.		
V. C. Proctor, Winslow, Ariz.		
D. A. Shope, Fresno, Cal.		
J. W. Wood, Needles, Cal.		
Atlanta & West Point R. R. and W. Ry. of Ala.	2	225
O. T. Nelson, Montgomery, Ala.		
J. C. Williams, Opelika, Ala.		
Atlantic Coast Line R. R.	1	4,361
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. and B. & O. S. W. R. R.	10	4,738
G. W. Andrews, Baltimore, Md.		
W. M. Clark, Pittsburgh, Pa.		
W. T. Hopke, Grafton, W. Va.		
J. T. McIlwain, Akron, O.		
W. S. Schenck, Connellsville, Pa.		
W. F. Strouse, Baltimore, Md.		
S. C. Tanner, Baltimore, Md.		
D. B. Taylor, Garrett, Ind.		
F. A. Taylor, Cumberland, Md.		
E. C. Zinsmeister, Zanesville, O.		
Baltimore & Ohio, Chicago Terminal R. R.	1	289
H. H. Eggleston, Chicago.		
Bangor & Aroostook R. R.	2	628
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.	1	210
H. D. Cleaveland, Greenville, Pa.		

Name of Road and Membership.	Members.	Mileage
Boston & Albany R. R.	1	392
W. F. Steffens, Boston, Mass.		
Boston & Maine R. R.	14	2,288
Cyrus P. Austin, Medford, Mass.		
C. C. Battey, Concord, N. H.		
J. P. Canty, Fitchburg, Mass.		
John Ewart, Boston, Mass.		
Andrew B. Hubbard, Boston, Mass.		
F. J. Leavitt, Salem, Mass.		
William A. Lydston, Salem, Mass.		
John Marsh, Lawrence, Mass.		
Albert Mountfort, Nashua, N. H.		
A. A. Page, Concord, N. H.		
S. F. Patterson, Concord, N. H.		
B. F. Pickering, Salem, Mass.		
Fred C. Rand, Boston, Mass.		
F. A. Sherwin, St. Johnsbury, Vt.		
Brazil Ry.,	1	10,000
A. M. Dodd, Sao Paulo, Brazil, S. A.		
Canadian Pacific Ry.	3	10,480
F. P. Gutelius, Montreal, P. Q.		
Frank Lee, Winnipeg, Man.		
D. A. McRae, Cranbrook, B. C.		
Carolina & Northwestern Ry.	1	133
J. W. Fletcher, Jr., Chester, S. C.		
Central of Georgia Ry.	1	1,916
H. C. McKee, Macon, Ga.		
Central Vermont Ry.	4	536
J. E. Cole, St. Albans, Vt.		
C. Donaldson, Waterbury, Vt.		
C. F. Flint, St. Albans, Vt.		
H. E. Holmes, New London, Conn.		
Chesapeake & Ohio Ry.	5	2,027
F. M. Griffith, Covington, Ky.		
Oscar L. Grover, Richmond, Va.		
C. E. Powell, Hinton, W. Va.		
J. M. Staten, Richmond, Va.		
C. W. Vandegrift, Ronceverte, W. Va.		
Chicago & Eastern Illinois R. R.	1	1,266
A. S. Markley, Danville, Ill.		
Chicago & North Western Ry.	30	8,101
L. J. Anderson, Escanaba, Mich.		
H. Bender, Eagle Grove, Ia.		
F. L. Burrell, Fremont, Neb.		
F. M. Case, Belle Plaine, Ia.		
O. F. Dalstrom, Chicago.		
H. H. Decker, Winona, Minn.		
T. H. Durfee, Huron, S. D.		
W. H. Finley, Chicago, Ill.		
M. J. Flynn, Chicago, Ill.		
G. W. Hand, Chicago, Ill.		
John Hunciker, Chicago, Ill.		
Lee Jutton, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage
Chicago & North Western Ry. Continued.		
C. A. Lichty, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
W. T. Main, Chicago, Ill.		
C. A. Marcy, Chicago, Ill.		
A. W. Merrick, Boone, Ia.		
W. F. Meyers, Belle Plaine, Ia.		
J. D. Moen, Boone, Ia.		
J. A. S. Redfield, Sioux City, Iowa.		
H. Rettinghouse, Boone, Ia.		
R. W. Richardson, Sioux City, Ia.		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		
D. Rounseville, Antigo, Wis.		
A. R. Shedd, Chicago, Ill.		
Wm. Spencer, Chadron, Nebr.		
W. M. Sweeney, Green Bay, Wis.		
H. M. Trippe, Chicago, Ill.		
J. B. White, Boone, Ia.		
Chicago Burlington & Quincy R. R.	3	9,075
Geo. Fenney, McCook, Neb.		
W. Hurst, St. Joseph, Mo.		
C. J. Scribner, Chicago.		
Chicago Great Western R. R.	1	1,492
H. A. Elwell, Clarion, Ia.		
Chicago, Indianapolis & Louisville Ry.	1	578
J. M. Caldwell, Lafayette, Ind.		
Chicago, Milwaukee & St. Paul Ry.	14	9,082
(and C. M. & P. S. Ry.)		
E. J. Auge, Wells, Minn.		
A. G. Bennett, Minneapolis, Minn.		
H. R. Drum, Chamberlain, S. D.		
L. D. Hadwen, Chicago, Ill.		
F. E. King, Milwaukee, Wis.		
N. H. LaFountain, Chicago, Ill.		
C. F. Loweth, Chicago, Ill.		
E. S. Meloy. Chicago.		
Edw. Murray, Miles City, Mont.		
William Ross, Milbank, S. D.		
Fred E. Weise, Chicago, Ill.		
William E. Wood, Chicago, Ill.		
A. A. Wolf, Milwaukee, Wis.		
A. Yappen, Chicago, Ill.		
Chicago, Rock Island & Pacific Ry.	6	7,551
McClellan Bishop, El Reno. Okla.		
C. H. Eggers, Little Rock, Ark.		
E. R. Floren, Chicago.		
M. E. Gumphrey, Eldon, Mo.		
W. V. Parker, Amarillo, Tex.		
R. C. Sattley. Chicago.		
Chicago, St. Paul, Minneapolis & Omaha Ry.	4	1,744
G. Larson, Hudson, Wis.		
A. G. Rask, Spooner, Wis.		
Aug. Ruge, Mankato, Minn.		
W. B. Rogers, Emerson, Neb.		

Name of Road and Membership.	Members.	Mileage
Chicago, Terre Haute & Southeastern Ry.	1	351
J. Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Cincinnati, Hamilton & Dayton Ry.	1	1,015
I. F. White, Indianapolis, Ind.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Colorado & Southern Ry.	5	1,250
R. W. Beeson, Trinidad, Colo.		
C. W. Fellows, Denver, Colo.		
Harry James, Denver, Colo.		
A. W. Pauba, Denver, Colo.		
W. T. Powell, Denver, Colo.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Concho, San Saba & Llano Valley R. R.	1	61
K. S. Hull, Temple, Tex.		
Copper Range R. R.	1	128
A. Giesing, Houghton, Mich.		
Delaware, Lackawanna & Western R. R.,	6	957
F. J. Arnold, Scranton, Pa.		
G. E. Boyd, Scranton, Pa.		
E. Cahill, Binghamton, N. Y.		
A. McQueen, Binghamton, N. Y.		
J. E. Ranney, Buffalo, N. Y.		
Jas. Skeoch, Dunmore, Pa.		
Denver & Rio Grande R. R.	6	2,598
G. W. Kinney, Salt Lake City.		
A. Ridgway, Denver, Colo.		
A. C. Snyder, Glenwood Springs, Colo.		
H. Taylor, Alamosa, Colo.		
C. S. Thompson, Denver, Colo.		
Jas. Vaughan, Salida, Colo.		
Duluth & Iron Range R. R.	2	168
W. A. Clark, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.	1	297
W. A. McGonagle, Duluth, Minn.		
Duluth, South Shore & Atlantic Ry.	1	586
W. M. Noon, Marquette, Mich.		
Elgin, Joliet & Eastern Ry.	3	770
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
C. Thompson, Gary, Ind.		
El Paso & Southwestern System	1	903
Bailey J. Mustain, El Paso, Tex.		
Erie R. R. (and Chicago & Erie)	8	2,665
O. F. Barnes, Susquehanna, Pa.		
W. O. Eggleston, Huntington, Ind.		
A. J. Horth, Meadville, Pa.		

Name of Road and Membership.	Members.	Mileage
Erie R. R. (and Chicago & Erie). Continued.		
F. A. Knapp, Jersey City, N. J.		
W. H. Matthews, Hornell, N. Y.		
Neil McLean, Huntington, Ind.		
A. Swartz, Huntington, Ind.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	1	708
E. K. Barrett, St. Augustine, Fla.		
Fort Smith & Western R. R.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Fort Worth & Denver City Ry.	1	454
J. M. Mann, Ft. Worth, Tex.		
Georgia & Florida Ry.	1	325
W. A. Swallow, Augusta, Ga.		
Grand Rapids & Indiana Ry.	2	592
W. S. McKeel, Grand Rapids, Mich.		
H. M. Large, Ft. Wayne, Ind.		
Grand Trunk Ry. System	4	4,756
A. Findley, Montreal, Que.		
George A. Mitchell, Toronto, Ont.		
H. C. Swartz, St. Thomas, Ont.		
C. F. Warcup, St. Thomas, Ont.		
Grand Trunk Pacific Ry.	2	2,440
L. H. Wheaton, Moncton, N. B.		
K. J. C. Zinck, Winnipeg, Man.		
Gulf, Colorado and Santa Fé Ry.	5	1,518
E. C. George, Beaumont, Tex.		
K. S. Hull, Temple, Tex.		
R. A. Luker, Silsbee, Tex.		
W. G. Massenburg, Beaumont, Tex.		
W. W. Wilson, Galveston, Tex.		
Hampshire Southern R. R.	1	38
W. Trapnell, Romney, W. Va.		
Illinois Central R. R.	10	4,750
P. Aagaard, Chicago, Ill.		
F. O. Draper, Chicago, Ill.		
C. Ettinger, Chicago.		
T. J. Fullem, Chicago, Ill.		
R. J. McKee, Freeport, Ill.		
Samuel P. Munson, Mattoon, Ill.		
William Reed, Grenada, Miss.		
C. E. Thomas, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	1	420
G. A. Wright, Decatur, Ill.		
Indianapolis, Columbus & Southern Traction Co.	1	62
A. Shane, Columbus, Ind.		
Intercolonial Ry.	8	1,468
T. C. Burpee, Moncton, N. B.		
John Forbes, Halifax, N. S.		
Hugh Jardine, Moncton, N. B.		

Name of Road and Membership.	Members.	Mileage
Intercolonial Ry. Continued.		
A. E. Killam, Moncton, N. B.		
H. J. McGrath, Moncton, N. B.		
W. B. McKenzie, Moncton, N. B.		
Thomas Sefton, Moncton, N. B.		
A. C. Selig, Moncton, N. B.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Browne, Clinton, Mo.		
Kansas City Southern Ry.	2	762
C. E. Johnston, Kansas City, Mo.		
J. J. Taylor, Texarkana, Tex.		
Lake Erie & Western Ry.	2	882
P. P. Lawrence, Tipton, Ind.		
J. N. Penwell, Tipton, Ind.		
Lake Shore & Michigan Southern Ry.	4	1,663
Willard Beahan, Cleveland, O.		
Philip O'Neill, Adrian, Mich.		
R. H. Reid, Cleveland, O.		
J. L. Soisson, Norwalk, O.		
Lake Superior & Ishpeming Ry., Munising Ry., and Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	2	96
J. E. Barrett, Warwick, N. Y.		
Lewis A. Riley, Warwick, N. Y.		
Lehigh & New England R. R.	1	170
W. E. Harwig, Bethlehem, Pa.		
Lehigh Valley R. R.	8	1,446
E. B. Ashby, New York City.		
Peter Hofecker, Auburn, N. Y.		
J. W. Holcomb, Buffalo, N. Y.		
Judson Joslin, Auburn, N. Y.		
David A. Keefe, Athens, Pa.		
A. E. Kemp, Hazleton, Pa.		
F. E. Schall, South Bethlehem, Pa.		
E. R. Wenner, Ashley, Pa.		
Long Island R. R.	3	392
Chas. Wehlen, Jamaica, N. Y.		
W. Wicks, Amityville, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Louisiana & Arkansas Ry.	1	255
W. H. Vance, Stamps, Ark.		
Louisville & Nashville R. R.	8	4,609
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Columbia, Tenn.		
H. R. Hill, Birmingham, Ala.		
Floyd Ingram, Erin, Tenn.		
A. B. McVay, Evansville, Ind.		
Wm. Sheley, Evansville, Ind.		
H. Stamler, Paris, Ky.		

Name of Road and Membership.	Members.	Mileage
Maine Central R. R.	1	1,180
P. N. Watson, Brunswick, Me.		
Michigan Central R. R.	5	1,803
S. D. Bailey, Detroit, Mich.		
Thomas Hall, St. Thomas, Ont.		
Henry A. Horning, Jackson, Mich.		
P. E. Schneider, Jackson, Mich.		
J. T. Webster, St. Thomas, Ont.		
Minneapolis & St. Louis R. R.	1	1,626
Ed. Gagnon, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.	3	3,770
A. Amos, Minneapolis, Minn.		
P. Swenson, Minneapolis, Minn.		
G. A. Manthey, Minneapolis, Minn.		
Miss. River & Bonne Terre Ry.	1	46
C. H. Fake, Bonne Terre, Mo.		
Missouri, Kansas & Texas Ry.	1	3,073
A. S. Clopton, Parsons, Kans.		
Missouri Pacific Ry. System (including St. Louis, Iron Mountain & Southern Ry.)	19	7,231
E. E. Allard, St. Louis, Mo.		
Robert J. Bruce, St. Louis, Mo.		
J. A. Costolo, St. Louis, Mo.		
E. M. Dolan, St. Louis, Mo.		
A. H. Ferdina, St. Louis, Mo.		
C. Gnadt, Poplar Bluff, Mo.		
Lon Graves, Monroe, La.		
W. Hausgen, Sedalia, Mo.		
E. P. Hawkins, Bastrop, La.		
W. J. Lacy, Poplar Bluff, Mo.		
G. W. Land, Eudora, Ark.		
C. E. Redmond, Van Buren, Ark.		
C. E. Smith, St. Louis, Mo.		
E. A. Stanley, St. Louis, Mo.		
Wm. Sullivan, Kansas City, Mo.		
F. W. Tanner, St. Louis, Mo.		
L. J. Wackerle, Kansas City, Mo.		
A. L. Waits, Argenta, Ark.		
C. H. Walther, Poplar Bluff, Mo.		
Mobile & Ohio R. R.	2	1,114
W. B. Harris, Murphysboro, Ill.		
B. F. Whiting, Murphysboro, Ill.		
Nashville, Chattanooga & St. Louis Ry.	1	1,230
I. O. Walker, Paducah, Ky.		
National Rys. of Mexico	1	6,177
Hans Bentele, Mexico City, Mex.		
New South Wales Government Rys.	1	3,472
James Fraser, Sydney, N. S. W.		
New York Central & Hudson River R. R.	8	2,829
G. J. Klumpp, Rochester, N. Y.		
R. P. Mills, New York City.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		

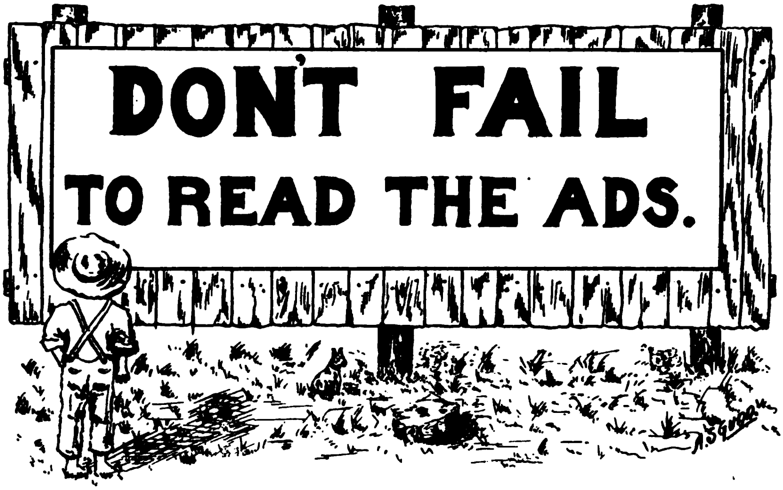
Name of Road and Membership.	Members.	Mileage
New York Central & Hudson River R. R. Continued.		
John Schaffer, Rochester, N. Y.		
H. C. Thompson, Weehawken, N. J.		
C. C. Warne, New York City.		
E. E. Wilson, New York City.		
New York, New Haven & Hartford R. R.	13	2,091
Grosvenor Aldrich, Readville, Mass.		
J. S. Browne, Providence, R. I.		
Wm. Graham, New Haven, Conn.		
H. H. Kinzie, Taunton, Mass.		
Wm. H. Moore, New Haven, Conn.		
B. P. Phillips, Willimantic, Conn.		
H. W. Phillips (retired), South Braintree, Mass.		
L. H. Porter (retired), Andover, Conn.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		
W. B. Schuessler, New Haven, Conn.		
D. W. Sharpe, New Haven, Conn.		
J. B. Sheldon, Providence, R. I.		
New York, Ontario & Western R. R.	1	494
J. H. Nuelle, Middletown, N. Y.		
New Zealand Government Rys.	2	2,717
C. H. Biss, Christchurch, N. Z.		
George A. Troup, Wellington, New Zealand.		
Northern Pacific Ry.	6	6,029
F. R. Bartles, Pasco, Wash.		
James Hartley, Staples, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
R. E. McFarlane, Duluth, Minn.		
J. C. Taylor, Glendive, Mont.		
North Western Govt. Rys. (India)	1	4,431
D. M. Cookson, Kalaw, Burma, India.		
Northwestern Pacific R. R.	1	372
A. A. Robertson, San Rafael, Cal.		
Oregon Short Line R. R.	8	1,646
J. F. Cullen, Pocatello, Idaho.		
W. C. Dale, Salt Lake City.		
O. Forsgren, Brigham, Utah.		
A. H. King, Salt Lake City, Utah.		
C. T. Musgrave, Idaho Falls, Idaho.		
P. E. Parsons, Salt Lake City.		
S. J. Powell, Ogden, Utah.		
R. B. Robinson, Rupert, Idaho.		
Pennsylvania Lines West of Pittsburg	8	2,763
Samuel C. Bowers, Steubenville, O.		
Stanton Bowers, Bradford, O.		
B. F. Gehr, Richmond, Ind.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		
H. H. Pollock, Carnegie, Pa.		
J. Wallenfelsz, Cambridge, O.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.	5	5,304
M. M. Barton, West Philadelphia, Pa.		
Richard G. Develin, Philadelphia, Pa.		

Name of Road and Membership.	Members.	Mileage
Pennsylvania R. R. Continued.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibbon, Altoona, Pa.		
C. W. Richey, Pittsburg, Pa.		
Pere Marquette R. R.	7	2,336
J. D. Black, Saginaw, Mich.		
Edw. Guild, Edmore, Mich.		
G. E. Hanks, East Saginaw, Mich.		
A. McNab, Holland, Mich.		
John Robinson, Grand Rapids, Mich.		
J. E. Toohey, Grand Rapids, Mich.		
J. P. Wood, Edmore, Mich.		
Philadelphia & Reading Ry.	5	1,490
Amos H. Beard, Reading, Pa.		
John Foreman (retired), Pottstown, Pa.		
W. W. Perry, Williamsport, Pa.		
E. G. Storck, Philadelphia, Pa.		
E. E. Templin, Pottsville, Pa.		
Pittsburg & Lake Erie R. R.	2	215
D. L. McKee, McKee's Rocks, Pa.		
G. H. Soles, Pittsburg, Pa.		
Queen & Crescent Route	1	509
E. L. Loftin, Vicksburg, Miss.		
Quincy, Omaha & Kansas City R. R.	1	261
T. F. DeCapito, Milan, Mo.		
San Antonio & Aransas Pass Ry.	1	724
G. J. Bishop, Yoakum, Tex.		
San Pedro Los Angeles & Salt Lake R. R.	3	1,075
F. M. Bigelow, Salt Lake City, Utah.		
W. C. Frazier, Los Angeles, Cal.		
D. W. Scannell, Salt Lake City.		
Seaboard Air Line Ry.	10	3,046
W. M. Barker, Scotia, S. C.		
P. W. Cahill, Tallahassee, Fla.		
B. B. Christy, Tallahassee, Fla.		
W. J. Gooding, Jr., Savannah, Ga.		
B. Land, Jr., Jacksonville, Fla.		
W. A. McDearmid, Tallahassee, Fla.		
J. C. Nelson, Portsmouth, Va.		
G. B. Smith, Jacksonville, Fla.		
J. A. Wilson, Woodbine, Fla.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.	2	319
O. H. Andrews, St. Joseph, Mo.		
Wm. Carmichael, St. Joseph, Mo.		
St. Louis & San Francisco R. R.	1	4,740
F. G. Jonah, St. Louis.		
St. Louis, Rocky Mt. & Pac. R. R.	1	106
Alf Brown, Raton, N. M.		
St. Louis Southwestern Ry.	2	1,451
J. S. Berry, St. Louis, Mo.		
Wm. Quinn, Tyler, Tex.		

Name of Road and Membership.	Members.	Mileage
Southern Ry.	14	7,089
D. A. Ballenger, Greenville, S. C.		
J. H. Blackwell, Charleston, S. C.		
James T. Carpenter, Princeton, Ind.		
H. S. Douglass, Charleston, S. C.		
W. F. Fraylick, Charleston, S. C.		
J. R. Fowlkes, Columbia, S. C.		
N. L. Hall, Greensboro, N. C.		
Joseph A. Killian, Jr., Charlotte, N. C.		
J. S. Lemond, Charlotte, N. C.		
D. W. Lum, Washington, D. C.		
J. W. Morgan, Columbia, S. C.		
T. E. Sharpe, Greenville, S. C.		
J. B. Teaford, Princeton, Ind.		
G. W. Welker, Alexandria, Va.		
Southern Pacific Company	44	6,663
C. J. Astrue, Oakland Pier, Cal.		
T. W. Bratten, West Oakland, Cal.		
H. Bulger, Oakland Pier, Cal.		
W. H. Burgess, Stockton, Cal.		
D. Burke, Tucson, Ariz.		
J. T. Caldwell, Bakersfield, Cal.		
W. S. Corbin, Los Angeles, Cal.		
Geo. Dickson, Oakland, Cal.		
F. M. Drake, San Francisco.		
B. F. Ferris, Los Angeles, Cal.		
J. F. Fisher, Sacramento, Cal.		
M. Fisher, Ogden, Utah.		
A. Fraser, Bakersfield, Cal.		
Neil Fraser, Sacramento, Cal.		
P. Fritz, Los Angeles.		
J. A. Givens, Sacramento, Cal.		
Jas. Gratto, Los Angeles, Cal.		
C. F. Green, Sacramento, Cal.		
P. Guisto, San Francisco.		
W. C. Harmon, Bakersfield, Cal.		
J. Hubley, Colfax, Cal.		
C. A. Jensen, Los Angeles.		
A. W. Lasher, Suisun, Cal.		
T. J. Linehan, Ventura, Cal.		
H. Lodge, San Francisco.		
J. B. Malloy, San Francisco.		
J. D. Mathews, Tucson, Ariz.		
F. D. Mattos, W. Oakland, Cal.		
C. W. McCandless, Ventura, Cal.		
D. McGee, Sacramento, Cal.		
A. M. McLeod, Oakland, Cal.		
E. C. Morrison, San Francisco.		
P. N. Nelson, San Francisco. Cal.		
H. Pollard, San Francisco, Cal.		
Geo. W. Rear, San Francisco, Cal.		
J. S. Replogle, Oakland, Cal.		
D. T. Rintoul, Bakersfield, Cal.		
A. L. Robinson, Stockton, Cal.		
W. W. Sheldon, Oakland, Cal.		
F. M. Siefer, Oakland Pier, Cal.		
E. J. Vincent, Los Angeles.		
A. Weldon, Bakersfield, Cal.		
J. G. Wiley, Dunsmuir, Cal.		
M. M. Wilson, Los Angeles, Cal.		

Name of Road and Membership.	Members.	Mileage
Tennessee, Alabama & Georgia R. R.	1	98
C. H. Fisk, Chattanooga, Tenn.		
Tennessee Central R. R.	2	326
E. M. Carter, Nashville, Tenn.		
J. M. Hurt, Nashville, Tenn.		
Texas & Pacific Ry.	1	1,885
E. Loughery, Marshall, Tex.		
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Union Pacific R. R.	2	3,498
Wm. A. Conkling, Omaha, Neb.		
J. Parks, Denver, Colo.		
Vandalia R. R.	1	829
J. L. McKee, Spencer, Ind.		
Wabash R. R.	2	2,514
A. O. Cunningham, St. Louis, Mo.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.	2	53
W. M. Cardwell, Washington, D. C.		
C. H. Spencer, Washington, D. C.		
Wellington & Manawata Ry. (New Zealand)	1	84
Arthur Williams, Wellington, New Zealand.		
Western Australia Government Rys.	2	1,943
W. J. George, Perth, Western Australia.		
E. S. Hume, Midland Jct., Western Australia.		
Western Pacific Ry.	3	934
T. J. Stuart, Elko, Nev.		
M. R. Krutsinger, Sacramento, Cal.		
Norton Ware, San Francisco.		
Wheeling & Lake Erie R. R.	3	496
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
C. A. Stelle, Canton, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
No. of members with roads	437	
Total mileage represented		230,529
Other members not connected with roads	62	
Total number of members	499	

INDEX TO ADVERTISEMENTS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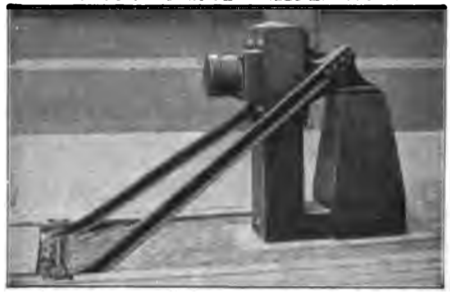

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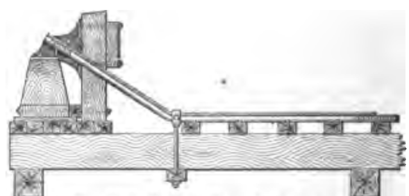

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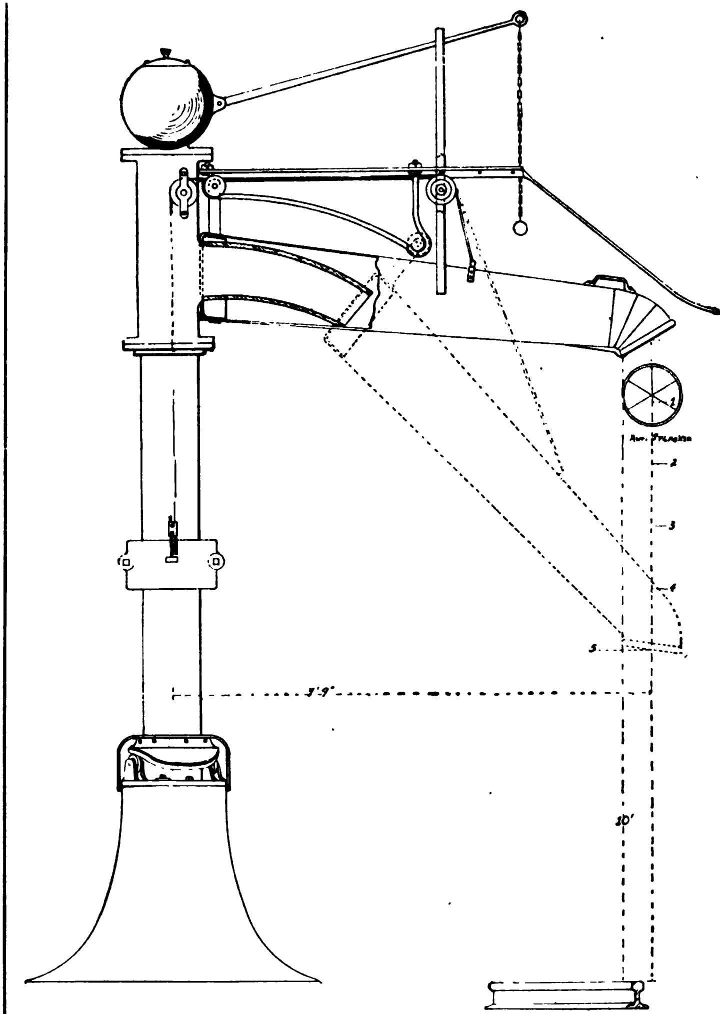

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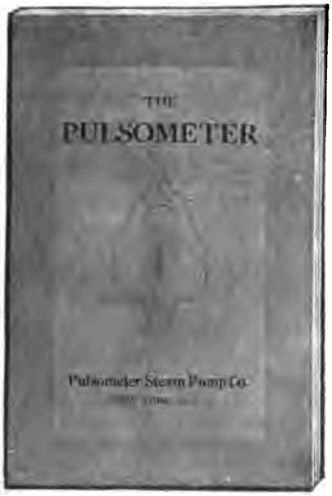

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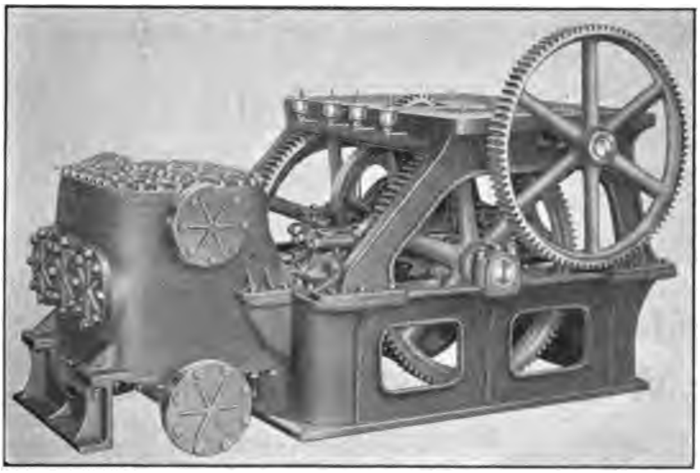

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LAKE SHORE, Corunna, Indiana..............3
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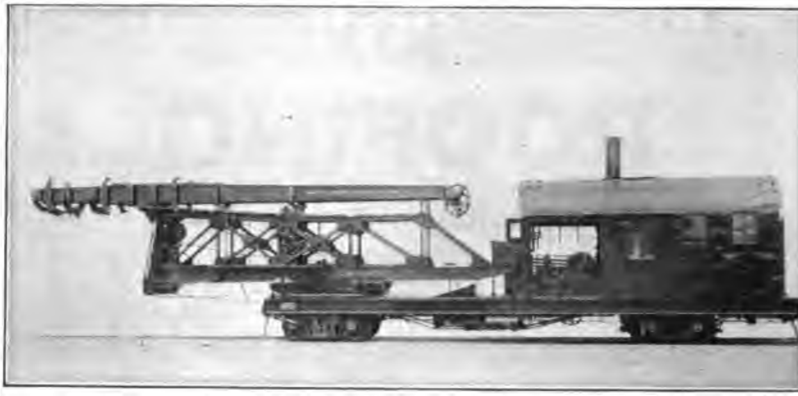

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